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A NATURALIST'S RAMBLES ABOUT HOME.

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A NATURALIST'S

RAMBLES ABOUT HOME

BY

CHARLES C. onrad ABBOTT

SECOND EDITION, REVISED

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NEW YORK
D. APPLETON AND COMPANY
1889

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PREFACE TO SECOND EDITION.

More than three years have passed since I penned the opening chapter, which was prefatory in character, of this volume of zoölogical sketches. Since then, I have spent much of every month in the field, and been always mindful of the fact that various statements of mine had been critically commented upon. I endeavored, whenever opportunity occurred, to prove whether my critic or I was in the right, and in this new issue of my book will be found the result of my efforts in this direction.

These changes refer more particularly to the mammals and reptiles. In the ornithological chapters I found little to amend. But, in reference to birds, I would have my readers bear three facts in mind : *first*, that I treat of a very limited area ; *secondly*, that the same species of birds sometimes differ very widely in habits, according to environment ; and, *thirdly*, that the movements of migratory birds are exceedingly uncertain, and the dates of their arrival and departure are of no significance except when careful observations cover many years. This is particularly true along that border-land between the northern or summer haunts, and southern or winter haunts, of migratory species ; and it is upon such bordering territory that I have spent my whole life.

Both in the body of the work and in the Appendix I have most carefully gone over every date, compared it with my field-notes, and referred the matter to excellent observers in other portions of the State, and have had no occasion to make any material change in the text of the original edition.

A word in conclusion concerning contradictory impressions, and, indeed, contradictory statements. The observer who is not continually perplexed by the former makes, I fear, but poor use of his eyes and ears. A critic has remarked that I sometimes claim a change of habit to have taken place, and again deny it, perhaps in the same chapter. I have not looked the matter up, but assume that it is true. What of it? It does not signify a want of correct observation, but that the same species is not always the same bird, judged solely by its habits. A red thrush back of my garden has, at this moment, a nest upon the ground; another of these birds is nesting in an ivy-wrapped sassafras, twenty feet from the ground. A Carolina wren is nesting now in the poultry-house; and last summer two nests were found in little caves on the hill-side—caves of the birds' own digging! The individuality of all our birds is strong—far stronger, I think, than that of any other class of animals. They live as suit their tastes, and as their surroundings permit and suggest. To take the nest of one pair of birds; to follow these individuals from one year's end to another; to mark their every utterance, and then to describe such nest, the habits and wanderings and voices of this one pair as the correct and unvarying life-history of all individuals of that species, would be just as absurd as to describe one individual man, with his wife and children, and imply that all men, women, and children were like unto them.

It is for this reason that no one person has written an entirely satisfactory history of our birds. Such a work must be the result of many observers in every nook and corner of the country.

It would be strange indeed if, in an effort to study the habits of about three hundred and fifty species of animals, I should not at times have fallen into error. This will surely result if the attention is divided among several objects; and yet how difficult it is to ignore five out of six creatures, when all are equally prominent features of the day's ramble!

I have in but very few cases endeavored to follow any animal from the cradle to the grave; but my aim has been rather to record my impressions of such as I saw, as I saw them; and never have I started out with the intention of making every creature I found conform to the rules laid down for its conduct by those who assume to know more about animals than these know about themselves.

CHARLES C. ABBOTT, M. D.

PROSPECT HILL, TRENTON, NEW JERSEY, *May 25, 1887.*

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A WORD AT THE START,

IN LIEU OF A PREFACE.

When I happen out for a stroll, the difficulty that besets me is not what to seek—for to ramble without an object is an abomination—but what to choose of the endless variety of objects worthy of attention. I do not like to determine this after I have started, but prefer saying to myself, "I will watch the birds to-day," or, "I will hunt up the meadow-mice." To do this, at once gives an additional interest to a contemplated ramble; and, in all my experience, I have never yet failed to find some trace, at least, of that object to observe which I took the walk.

Avoid the highways when you take a walk. Even if well shaded, they are abandoned now to the pestiferous English sparrows; and if you are really intent on a good tramp of a few miles, do not turn aside for a stretch of swamp. If you have any fear of wet feet, be properly shod before starting. It too often happens that the sights best worth seeing come to you when in a bit of wet meadow. The swamp-sparrows, that are such sweet songsters; the marsh-wrens and the king-rails and soras will not come to the dry ground at the edge of the meadow and sing and show themselves for your benefit. If you want to enjoy them, you must go to their haunts; and once there, if you are really fond of birds, you will never regret it. There are neglected, tangled, briery nooks in every neighborhood that will repay frequent visits. There some of the best bird-music is to be heard. In an old field I know of, too barren to be worth cultivating, and unpleasantly strong with the odors of Jamestown weed, there is every summer a whole colony of Carolina wrens, and their songs are not excelled by any of our birds, except certain thrushes and the rose-breasted grosbeak. In this same field, too, I am sure of finding scores of garter-snakes, and the pretty creatures add a charm to the place. Finally, nowhere else are there so many gorgeously-colored dragon-flies as about this same neglected, weed-grown field. By very many, walks are thought to be enjoyable only in what is commonly called pleasant weather. What constitutes a pleasant day, as distinguished from an unpleasant one, is not very clear. If I have seen something new, that day is pleasant, however the thermometer registers or the winds blow. Surely, too, after a month of sunny days, a steady, pouring rain is delicious, not to look at merely, but to be about in it. It is charm enough to tempt one out to see how the birds and mice and squirrels, and the snakes, frogs, and insects pass their time when it rains. The cunning you will see displayed by them will compensate for the soaking you may get.

If the weather be cold, walk fast and see fast, and, if you have well-trained eyes, no feeling of cold will annoy you; unless, indeed, you are needlessly bundled up, and do nothing but wonder where the thermometer ranges. A good rule for one who walks in winter is, to forget that there are such things as thermometers, and never to look at one when leaving the door-step. Perhaps it is snowing. Well, the very creatures that the observant walker loves to see can not more readily dodge the snow-storm than he can; and is it not a sufficient incentive to learn what the birds and mammals are about when snowed up, to warrant a ramble over snow-clad fields and in the leafless woods? Who that has seen a cardinal grosbeak in the full glory of his crimson dress, perched upon a bare twig, with nothing but untrodden snow for a background, and heard his cheery whistle come ringing through the crisp air, can ever forget it? Such a sight is not to be witnessed from your sitting-room windows. No, no, there is reason for rambling at all times, with perhaps one exception. In the noon of midsummer days it is proper to remain in-doors to rest, to keep cool, if happily you can. Nature herself, just then, is taking a nap.

A word, now, as to where my home is, for I have never rambled elsewhere. I will not attempt a description; for why, indeed, should I expose its nakedness? It came to me not through purchase, but by the accident of birth. Just two centuries ago, a lad came from Nottingham, England, to what was then a mere ghost of a village, but is now the present city of Philadelphia. By chance he came into "the Jerseys," and, when of age, chose, as a site for the home he purposed building, a tract on Crosswicks Creek, a navigable stream that enters the Delaware River at Bordentown. By trade a wheelwright, but by choice a farmer, he throve well, and added hundreds of acres to his original purchase; and now, two centuries later, I find myself anchored within sight of where my respected ancestor dwelt. Yes, and writing these lines at a curious old desk that belonged to his thrifty son, who bought other lands, built boats, and died early of grief, because the breaking out of the Revolution spoiled his plans. The predecessors of my ancestors, as possessors of the soil, merit a moment's attention. These dusky-skinned natives were greatly attached to the neighborhood, and the abundance of their handiwork in stone still testifies to their prolonged occupancy of the country. Not only are there hundreds of their relics on every acre, but there is also a fragmentary tradition that, not far from my door-yard, Oconio-coco-coco-cadgi-cadgi-cadonko had his wigwam; and not far off, under an enormous white-oak, fought single-handed with the fiercest of cougars, long the terror of the neighborhood, and slew him with a flint knife. Oconio's grave is supposed to be quite near, but I have never sought to disturb his bones, much as I would like to have them, nor have I even looked for a wonderful stone pipe that was buried with him. Perhaps it is all true. I accept it as such, because it is pleasant to recall the story, as told me nearly forty years ago. I have often tried to determine, in various ways, how long these Indians roamed along this terrace and over these fields and meadows, but have not as yet reached a satisfactory conclusion. That they were here for a long time can not be questioned, and even now, so long after their departure, the traces of their former presence lends a charm to our quiet rambles; for, whenever we happen upon bare ground, the chances are that we shall see an arrow-head, and what a wealth of pleasing fancies even a single arrow-head may bring up! How many possible occurrences may be connected with this bit of chipped jasper! So it is, indeed, the country over; and often an unsuspected mine of pleasure is lying exposed to the gaze of those who, walking abroad, see nothing and learn nothing.

Relic-hunting, properly conducted, is an art, and had better be treated as such. It is too laborious for quiet rambling—as the eyes must always be fixed on the ground.

Here, to-day, much as in the olden time, are the broad stretches of meadow that, skirting the Delaware, are my constant delight and the scenes of my happiest days out-of-doors. Back from the river, more than half a mile, and parallel to it, is the elevated plateau that extends eastward and seaward. From the one to the other there is no sloping, intervening stretch of land, other than the meadows. To pass from the uplands to the lowlands you must trip down a steep descent of eighty feet. Steep as it is, it is well wooded, and is the "hill-side" of which I shall say much hereafter. It is a jolly place for those given to quiet rambles. There the earliest spring flowers are to be found, and to gather the earliest bloom of the year is surely worth an effort. There, too, tarry the forerunners of the flight of summer songsters that gladden the hearts of all who hear their melody, for no subsequent songs are so charming as the first notes of the pioneer thrush, red-wing, or oriole.

My house stands on the very edge of this terrace, and is so placed that from my windows I can see the meadows below and the river beyond. A substantial structure it is, and it answered my great-grandfathers' modest wants though it does not suit me; still I am compensated for what it lacks, in the oaks, beeches, and locusts that surround it, as it is under them that I live. So much, then, as to the place where I live. Evidently there is not a single romantic feature in the neighborhood. The first Europeans who settled here were Quakers, and the plainness of the surroundings doubtless had its influence in deciding their choice. So strict were they, as their meeting records show, that probably they would have covered up any natural beauty that might have had a tendency to foster a poetical sentiment among their people; just as they desired their blooming maidens, if their color was too bright, to dust their cheeks with flour before attending meeting. It proved to be a "concern" upon the minds of the elders lest the aforesaid rosy cheeks should distract the attention of the young men who sat on benches so placed that they could look upon the fair faces of these maidens. Even in such prosaic times the young men thought a pretty girl was more to be desired that a drowsy sermon, and their seniors chided them for so thinking. The descendants of these Quakers, happily less strict, still assemble in the old meeting-house.

But long years ago a gifted man, Archibald, nephew of William Bartram, the naturalist and traveler, thought otherwise of this neighborhood and the young maidens of his day. Of these meadows and the wooded bluff he sang:

"Sweet Nottingham! thy charms I prize,
Where yonder hills abruptly rise,
Which gird thy valleys green;
At dawn, at noon, at close of day,
Along these heights I love to stray
And gaze upon the scene."

This, and much more, he found to say about the spot during his many visits, just eighty years ago—found it to say, too, in spite of living in Bartram's garden on the Schuylkill, where there was so much to attract a poet and naturalist. The matter, perhaps, is explicable from the fact that a maiden was even more attractive than the neighborhood, and a suspicion crosses my mind that, childlike, he "made believe" to have discovered the beauty of the locality, hoping it would please the dark-eyed damsel. In this he succeeded. She was pleased, and all would have gone well, had he not, so soon after, passed away. From about this time these meadows and the bluff attracted many naturalists of repute, then living in Philadelphia. Conrad the elder, botanist and mineralogist; Conrad the geologist, his son; and Rafinesque, Say, Le Sueur, Bonaparte, Wilson, and others, all rambled about here. Indeed, the names of some, cut by themselves, are still to be deciphered on one of the old beeches that guards a famous spring, where they were wont to halt at noon-time.

An instructive, pleasant, leisurely stroll is not unprofitable, even if the more striking objects of natural history are absent. It is a sad error to suppose that the most familiar of our birds, to say nothing of other forms of life, both vegetable and animal, can ever be so familiar that nothing further can be learned by observing them. There is a percentage of probability so large that we may detect something quite new to us in the habits even of the little social chipping sparrow, that it is unwise even for the experienced ornithologist to pass them by unheeded. If it is early summer, you may happen to find its nest. Of course, you know it is always lined with hair. Well, look at the nest you have found, nevertheless, if you can without disturbing it, and perhaps you may find a different material used. I did once, and once only, and it was a more pleasant discovery than many I have since made. As I continued my walk that same day, I pondered long on the subject of variation in nest-building, and found half a dozen other nests of birds before I returned. One was a delicate, pensile structure, apparently too fragile to hold safely the three little eggs it contained; yet with them was an egg of the Cowpen bird, larger than the three others together.

If a walk is taken for mental as well as bodily exercise, it is most unwise to ignore familiar objects, or refuse to ramble because there is nothing to see. When once the impression of nothing to see gains possession of a person, he is in a bad way, as he is deprived of one great source of pleasure, and must acquire his knowledge at second hand or not at all. Not that I think little of a book-knowledge of Nature, for I read many books with delight; but the best book is that which sends us out-of-doors, in search of information, rather than to the library.

Walks may be taken alone or in company; but if you go with a companion, be sure he is thoroughly sympathetic, or the ramble will be in vain. The best company are those that live closest to Nature, and he is wise who is friendly with the old trappers and fishermen who still linger in every village. If the rambler is young, and learning Nature's A, B, C's, an opportunity to question an old trapper is something to be prized. More can be learned of them, by judicious questions, than by reference to a cyclopædia. Aspiring, then, to be an accomplished rambler, to know how to stroll profitably, be not less on the lookout for those whose business is with Nature than for those lower forms of intelligence we call, collectively, animal life. A chance conversation discovered to me one companion of many of my walks. When a mere boy, Uz Gaunt lived in this neighborhood, having a little cottage adjoining my grandfather's woods; and he, above all others, gave me my first lesson in practical zoölogy.

When I first met him he was about seventy years old, and ten years later he appeared no older. Had he not been bent and disabled, finally, from severe rheumatic attacks, I doubt if any one could have guessed his age. His hair remained dark and thick, his forehead showed few wrinkles, his eye was as bright and piercing, at the last, as when, a score of years ago, he would point out the green head of a mallard in the tall grass and bid me shoot. Often I would fire on faith, not able to detect anything but the waving grass wherein he saw a cunning mallard hiding.

Uz was the happy owner of a few acres, most of which were not arable. The five acres that immediately surrounded his house were shut in from the world by a swampy tract that remained undisturbed. Tempting offers were made for the valuable timber that grew upon it, but Uz had enough to meet his wants, and turned a deaf ear to all who suggested his parting with the trees. "They were my only companions when a child," he once remarked to me, "and I could not part with them now. I'm not chicken-hearted, that I know of, but to sell those trees would be like selling my own flesh and blood. They are a part of my life now, and my sister and I make out to live on the little patches of cleared land about the house. No, so long as I live I want the trees to keep me company."

"Then it is from the fact that you played all day under these trees that you became a naturalist," I suggested at the time.

"Yes, you hit it there. Of course, I went a bit to school, and father had two or three books which I read in a little, but my learnin' came from outdoors. Why, the birds seemed to know me after a while, and I gained their good-will by lettin' 'em alone.

My eyes would be on 'em all day, but I kept my hands off."

"But you carried a gun after a while," I remarked.

"Yes, but not for some time. Father made me work some, and when I did go gunnin' it was at proper times, and I didn't shoot birds in spring just to count their tail-feathers." This was a quiet dig at me, for Uz had but little patience with ornithology as I had attempted to study it. The minutiæ of color and anatomical structure he gave the go-by, but knew the habits of birds as I never expect to.

In later years Uz left to his sister the care both of his house and little farm, and was ever on the alert, with gun in hand, to secure what game might be at hand. The number of rabbits he killed every autumn I dare not mention; and, in the proper season, woodcock, quails, and ducks daily rewarded his rambles about their haunts. As a duck-shooter he had no equal in the neighborhood, and it was in this sport that he most delighted. For twenty years, during which I knew him well and saw him often, his sole occupation was that of a hunter and trapper, and, happily, he combined with these all the essential requirements of a practical naturalist.

To him I feel that I am indebted in great part for my liking for the great world of out-of-doors, and for a total indifference to the artificial, pent-up life of the city. He it was who taught me how to stroll leisurely about when I felt so disposed, and to see a wealth of wonder everywhere I went. It is proper, therefore, that I should here give him the credit that is his due; and, in so doing, point out to others the desirability of seeking out in their respective neighborhoods other Uz Gaunts, and profiting by their acquaintance. There are few villages that do not contain some one who is better informed than his fellows as to the natural history of the neighborhood; and it is possible that what you fail to discover during your rambles will be learned by applying to the practical Uz Gaunt of your neighborhood. Such was my experience, and, in advising my readers to adopt a similar course, I can only hope that they may be so fortunate as to meet with one whose love of Nature was as sincere as was that of my old friend and teacher; and, that they can the better realize what manner of man he was, I have ventured to add "specimen days" spent with him, and record some of his observations in his own words.

As a result of many years of rambling about home, I have seen most if not all of the animals that are now to be found here; and, whenever I saw any of them under circumstances that were of peculiar interest, I made a note of it. At various times, and in various publications, as "Hardwicke's Science Gossip" and "Nature" (London), "The American Naturalist" (Philadelphia), "Science" (Cambridge), and "The Popular Science Monthly" (New York), some of these field-notes have already appeared. The willingness, on the part of the publishers of these various serials, to have me reproduce them in their present form, is here gratefully acknowledged.

Rather than mar the pages with innumerable brackets, inclosing the scientific names of the animals I have had occasion to mention, I have added a complete list of the mammals, birds, reptiles, batrachians, and fishes of Mercer County, New Jersey. The common or local names I have used in the body of the work are here repeated, with the name now adopted by the systematists. This list will prove, I hope, of some value to those interested in the subject of the geographical distribution of our animals; and will, at least, prevent any difficulty in properly identifying any animal to which I have referred under its common or local name.

If these "notes," the gatherings of many years, shall serve to amuse or instruct my young readers, or those of maturer years, if any such there be, then I shall be quite satisfied with having preserved that which is here given to the public.

C. C. A.

Prospect Hill, Trenton, New Jersey, *March 1, 1884.*

RAMBLES ABOUT HOME.

CHAPTER I.

OUR MAMMALS IN GENERAL.

THE marked changes that have taken place in the surface of our country since its settlement, more than two centuries ago, have naturally had their effect upon the fauna. This is realized most readily when we compare our present meager list of mammals with the goodly array of "mightie beestes" that once roamed through our primeval forests. Even earlier—in the Indian or prehistoric times—faunal changes occurred, of even greater magnitude than any that have since taken place, for, partly through climatic change, but more through incessant persecution, the moose, reindeer, and bison had disappeared from New Jersey, and the mastodon had become extinct, long before the arrival of the whites.

The bear, elk, deer, wolf, cougar, and beaver still remained in vast numbers, however; and, although the Indians were essentially a hunting people, and depended largely upon the product of the chase, yet the many animals that were once common here might have held their own, had not the occupation of the country by the Swedes, and the consequent introduction of fire-arms and destruction of the forests, brought about results that were most disastrous to the larger mammals. It was this latter cause, perhaps, more than all else, that affected the larger animals of New Jersey, within historic times; for, as their haunts were invaded by the settler, they were driven first to the remote mountain, forest-clad swamps, and then westward, as was the Indian; and the presence ever afterward of the European prevented, in great measure, their return even to those localities where a new forest-growth replaced the old. Notwithstanding all these adverse conditions, the bear and deer still linger within our boundaries, while the wolf has only been exterminated within fifty years, and the elk and beaver almost as recently. That all the animals mentioned were once common here is proved by the presence of their bones in the shell-heaps or kitchen-middens of the Indians, and also by the accounts of the early travelers and settlers. Especially are we indebted to Peter Kalm, the Swedish naturalist, for many most interesting details of the fauna of the country as it was a century and a half ago; and it is most instructive to compare his account of the habits of the mammals, that were then found here, with our own experience of the fauna that still remains among us. For instance, writing of New Jersey, in 1748, he says:

"Bears are very numerous higher up in the country, and do much mischief. Mr. Bartram told me that when a bear catches a cow, he kills her in the following manner: he bites a hole into the hide, and blows with all his power into it, till the animal swells excessively and dies"; and again: "They have two varieties of *wolves* here, which, however, seem to be of the same species. . . . All the old *Swedes* related that during their childhood, and still more at the arrival of their fathers, there were excessive numbers of wolves in the country, and that their howling and yelping might be heard all night. They likewise frequently tore in pieces sheep, hogs, and other young and small cattle." But a few years afterward they seemed suddenly to decrease in numbers, for in the year mentioned Kalm tells us that "they are now seldom seen, and it is very rarely that they commit any disorders. This is attributed to the greater cultivation of the country, and to their being killed in great numbers. But further up the country (i. e., up the Delaware Valley), where it is not yet so much inhabited, they are still very abundant."

Some of our smaller mammals, on the other hand, appear to have been benefited by the change from a wild to a cultivated country, as, for instance, the squirrels, of which Kalm says: "The several sorts of squirrels among the quadrupeds have spread: for these . . . live chiefly upon maize, or at least they are most greedy of it."

Speaking of one other well-known mammal, now no longer found in New Jersey, the same author writes: "Beavers were formerly abundant in *New Sweden*" (New Jersey), "as all the old Swedes here told me. At that time they saw one bank after another raised in the rivers by beavers. But after the *Europeans* came over in great numbers and cultivated the country better, the beavers have been partly killed and partly extirpated, and partly removed higher into the country, where the people are not so numerous. Therefore there is but a single place in Pennsylvania where beavers are to be met with; their chief food is the bark of the beaver-tree, or *Magnolia glauca*, which they prefer to any other."

Deprived of so many of these most interesting animals, it would seem as if the limited areas of woodland still remaining were destitute of any features of mammalian life worthy our attention. This would be true, if the most interesting problems in biology could be solved only by the study of the habits of the larger animals; but if we have not the cougar, we have the lynx; if not the elk, we have the deer; and if not the beaver, there remains the musk-rat; and it is to the study of the habits of such smaller creatures as have withstood the encroachment of man that our attention will be directed, and not to the past, when a larger, fiercer, and more attractive fauna dwelt within our borders.

In studying the habits of the few mammals that remain in New Jersey, it would, indeed, be interesting to determine to what extent their habits may have changed, since their environment has been so greatly altered by the destruction of forests, the drainage of swamps, and the cultivation of so large a portion of their former domain. I have already mentioned these changes, among others even more patent, as having aided in the extermination of most of our larger mammals; and it remains now to inquire how far the smaller ones that are left have retained their old habits, and whether they have acquired any that are new. As their altered surroundings must surely have increased the severity of that struggle for existence that greets every creature born into the world, it becomes an interesting inquiry whether the same causes have likewise increased their cunning and quickened their wits. When we come to consider certain phases of bird-life, we will find that man's presence has changed some of their habits to a marked degree, and the same might reasonably be expected in the case of our mammals. I confess, however, that I have been able to find but few indications of such changes, and the accounts of the habits of the raccoon, musk-rat, and mink, as detailed by Kalm, seem to be as applicable to these animals to-day as when they were written. Still, the field-notes as to the habits of our mammals, in their present environment, are far from being devoid of interest and permanent value, and when it is remembered that traits that are peculiar to an animal in one locality, may not be characteristic of the same animal elsewhere, there is but little danger that the observations of a naturalist, even of familiar objects, will prove, in all respects, a twice-told tale.

CHAPTER II.

GLIMPSES OF WILD-CATS.

To the world-wide traveler, the little stretch of meadows that intervene between my house and the river are, no doubt, exceedingly tame and uninviting; nevertheless, to me they possess innumerable charms; and I never weary of looking at them from the brow of the terrace that forms their eastward boundary. To me, indeed, they are as varied as a checker-board; and a bird's-eye glance at them, such as one gets from the terrace, suggests this comparison. In about equal proportions they are separated by creeks and ditches into high and dry, and low and wet; not divided into two great parts, but rather into a series of equal parts, evenly distributed.

In June, 1860, there was a remarkable fall of rain, lasting from the 1st to the 4th of the month. The rainfall measured a little more than six inches, and as the storm extended well up the river, the stream was enormously swollen; in other words, we had a summer freshet that submerged the meadows to the depth of from six to ten feet. This, of course, upset the calculations of the meadow-haunting birds, who had either to conform to the new order of things, or else to quit the neighborhood. Fortunately, the latter alternative was accepted by but few. As a result, I was astonished to find king-rails and woodcocks, and even the timid least bittern in the nearest high, dry, upland fields, skulking among the bushes that grew in the angles of the worm-fences. The musk-rats and otters, too, were drowned out and came to the slope of the terrace, seeking shelter in its wooded portions; and the minks reveled in an abundance of drowned nestlings that were floated to the shore. This latter fact was new to me, as I had never known minks to eat of food that they had not captured and killed. During this summer freshet the animal life on the meadows was literally set afloat, and thus familiar animals were placed in situations that called for the exercise of great ingenuity. This, of itself, should be enough to satisfy any naturalist, as it not only offered a rare chance for the study of these well-known animals, under conditions that were altogether new; but the fauna of the meadows was increased by scores of animals that found refuge upon the drift-wood, and were borne along by the current until meeting here, for the first time, with open bottoms and the river spread over a wide expanse of country and deposited many of the unwilling travelers. Among the mammals that were thus brought into the neighborhood —at least their presence may be explained in this way— were several wild-cats.

Under the circumstances, it was natural that I should spend the day, wandering here and there, upon these flooded meadows, and feasting my eyes on the many sights that were to be seen. It was, for the time, a first-class menagerie, better than any museum or "zoo" I had ever visited, because more instructive.

Night came all too soon, but still I lingered, hoping for further novelties to appear, nor was I disappointed. While yet a little sunlight lingered in the west, my attention was called to a commotion, not far off, wherein both beasts and birds were concerned. As I was floating almost aimlessly in my canoe, I heard a scream that was quite strange to me, and, looking in the direction from which the sound came, I was astonished to see a huge wild-cat, or bay lynx, standing upon a floating log, with its back arched and hair standing straight up. In the brush-wood, that had been drifted with the log, stood a turkey-buzzard, evidently entertaining no fear of the cat, even if it had no designs upon it. A quarrel was going on between them, I supposed, and my only thought was how I might be there to see. To be sure, it was growing dark, but this availed me nothing. I had no screen on the canoe, and indeed could only sit bolt upright in the little craft. If I went too near, the buzzard would fly; perhaps, too, the cat would swim off, although I had doubts as to the latter event. Accepting matters as they stood, I paddled to within a dozen yards, and then, checking my course, kept the canoe in one position, with as little movement on my part as possible, and became a silent spectator. Of course, both the cat and the buzzard saw me, and glared at me and at each other alternately; but neither changed its position, except to move its head. There was evidently a mystery about it. Things were not as they seemed. These creatures, it was now apparent, were not there of their own choice. Satisfied of this, I drew a little nearer. At this, the buzzard raised its wings, solemnly shook its head, and expressed its disapprobation by ejecting a semi-fluid mass of half-digested matter, the odors from which were not suggestive of "Araby the blest." Still, the buzzard remained at his post, and I at mine. As to the cat, it held this act of the buzzard to be adding insult to injury, and struggled terribly to be free; and now, for the first time, I saw that it was a prisoner. One of its fore-feet was securely held in the jaws of a large steel trap, which was fastened to the log. The truth was now plain. The animal had been caught during the recent storm, miles up the river, and subsequently tree, trap, and cat had floated thitherward together. Being no longer afraid that it might run away or swim off, I ventured to approach a little nearer. My curiosity now centered in the turkey-buzzard, for apparently there was nothing to prevent its flying away, and, as it is a timid bird, I was indeed sorely puzzled. Going yet a little nearer, I could just make out, in the uncertain light, that a sheep was floating in the brush-wood, and was partly upheld by it. On this the buzzard had feasted, notwithstanding the proximity of the snarling cat, and now it was so gorged that it could not fly, as the bird must needs have a chance to take a little run and jump before it can mount upward. Standing on a mat of drifting brush-wood, this was impracticable, and, while free in one sense, the bird was, for the time being, as essentially a prisoner as the trapped wild-cat.

Finding that I could not direct the floating mass to the nearest dry land, in consequence of its bulk, I concluded to remain conveniently near and see what might happen. It soon, however, became too dark to distinguish either cat or buzzard, and I left them for a time *in statu quo*. Some hours later, by bright moonlight, I paddled to the spot again, but found the currents had changed the position of the floating mass and its living freight. The raft had lodged against a tree-top and become firmly fixed, and the buzzard had been given a chance. At all events, the bird was missing. Not so, though, the cat. It was still on the log, but not standing up. Going closely to it, I found that it was sorely wounded and both eyes were pecked out. There was no doubt but that the buzzard had realized the cat's helplessness, and, although gorged with savory mutton, had attacked the poor creature "out of pure deviltry." I ended the cat's misery by shooting it.

The last wild-cat I saw (1876) was met with most unexpectedly. For weeks I had been watching the movements of a family of ground-squirrels, or "hackees," as we call them, racing to and fro along the garden-fence. I had followed them up persistently, and once I had dug out one of their subterranean homes. The family history of those ground-squirrels I had well-nigh unraveled, and was disposed to worry them no more. Late one pleasant autumn afternoon, while lying, half concealed, in a mat of long grass, watching the few ground-squirrels that were scampering about, I noticed that suddenly a great fear overcame them. They ran to and fro, with no apparent object, and kept up an incessant squeal-like bark. Turning in every direction to see the cause of this sudden commotion, I at last discovered, crouching on the trunk of a lately-hewed chestnut-tree, a fierce wildcat, that looked as though it would kill all the squirrels by its angry glances. I have never seen at any time so thoroughly devilish a countenance on any animal as in this case. In the murderous jaws of the cat was a squirrel. I remained perfectly still, having the animal in full view. Presently it let the captured squirrel fall, and, placing one fore-paw upon it, the cat gave a long, low growl, very unlike any sound made by the domestic cat. It was repeated at short intervals, and not being responded to, so far as I could detect, the animal again caught up the dead squirrel and bounded into the thickets. I followed cautiously but rapidly, and soon found the animal again. It was now crouching at the foot of an enormous oak, and with much snarling and low mutterings was devouring the squirrel. This accomplished, the cat curled itself up in a little patch of sunshine to take a nap. I cautiously withdrew; but on my return soon after with a gun, I found the cat had left for parts unknown.

CHAPTER III.

WICKED WEASELS.

THOUGH not generally known to farmers and poultry-raisers, there are two kinds of weasels found here, and I am disposed to believe that one is as seldom in mischief as its larger cousin is out of it. For a long time I did not recognize any difference between the many weasels that I made note of. They varied greatly in size, but not otherwise. In my field-notes, it is true, I find distinctions made, under such headings as "little" or "short-tailed" weasels, to distinguish certain individuals from others that were typical examples of the commoner weasel or ermine. It appears that this difference in size is of "specific value," as the systematists have it, and what shall follow refers to the "little weasel," a beautiful creature, in color brown above and white as snow beneath, and with a little pointed tail of a uniform brown color. This little weasel is not nearly so common as the ermine.

The true ermine, or large weasel, is well known everywhere, and needs no further mention, except to say that in New Jersey it very seldom turns white; and to question the statement of Audubon that in autumn they do not remain together, and do not hunt in company. I am fully convinced that the individuals of a family, at least, frequently, if not habitually, remain together until March or April of the ensuing year, when they separate. In two instances, both occurring in the month of November, several weasels were caught in traps, in the course of three successive nights, and one was found to be an adult male, another a female, while the others, being smaller, were therefore believed to be the young.

I have knowledge, also, of a man being attacked by several weasels and badly bitten by them. Before he escaped from their fury, he managed to kill two of them, and I judged these at the time to be an adult male and a young one of the summer just past. The man who passed through this novel but dangerous experience believed there was "at least a dozen of them in all"; and I have no doubt but that it was a family of weasels that were then hunting or traveling in company.

During the past few years I have, during winter, met with an occasional specimen of the smaller weasel, one of which was white. It fell into the hands of a taxidermist, and was lost to science. It measured, before skinning, six and one half inches from the tip of the snout to the root of the tail. The tail itself measured two and one fourth inches to the tip of the last caudal vertebra, beyond which extended a few coarse hairs.

Like all of the tribe to which this little mammal belongs, this creature has the graceful, wavy gait, when rambling about, that is so characteristic of the common or larger weasel. If unmolested, it moves deliberately, and from side to side, as though ever on the watch for prey. If pursued, the gait alters somewhat, the body is less curved, and it scampers off at great speed, although not so fast that a good running dog or even a cat can not overtake it.

Quite diurnal in their habits — although nocturnal, too, I suppose—they not unfrequently come to our very door-yards, and I have known one to be killed by the cat, which probably mistook it for a ground-squirrel or "chipmunk." When seized, it discharged from infra-caudal glands a fluid having a faint mephitic odor, which evidently so far sickened pussy that she was content with simply killing the animal, and did not attempt to eat it, play with it, or carry it off.

So far as I have observed, the little weasel prefers wooded hill-sides, with a southern outlook. This may not, of course, be applicable to the animal as found in other places. Those that I have seen were all on the one sunny, wooded hill-side, which has been my only hunting-ground. Given the woods, there must needs be an open meadow near, for it is to the latter that they go to hunt; while in the former they have their nests and find safe cover from pursuing foes.

In May, 1878, a pair of these small weasels took up their abode near my house. My first intimation of their presence was the marked diminution in the number of ground-squirrels, or chipmunks, which I had intended to carefully study. Then a young chicken, now and then, was found lying dead, with a hole in its neck. The cry of "Weasel!" was set up, but none were seen for some time. During the first week in June, as I was looking for birds' nests, I spied one of these animals running in the path ahead of me. Like a flash it disappeared in a stump that extended into the path. I followed it up, with all possible dispatch, and from the "signs" it was evident that this weasel had its home here, and was continually going and coming out of a little tortuous passage-way among the roots of the stump. I kept my own counsel, and quietly followed up my discovery with the following results:

The pair proved to be quite diurnal in their habits, however they may have spent their nights, and were frequently seen, at various times of day, but never together. On emerging from its semi-subterranean retreat, the animal did not appear to look about, but straightway darted off into a thicket of blackberry-bushes near by, giving great leaps, as though fearful of leaving behind any scent or trace by which the nest could be found. I noticed this sudden darting from the entrance beneath the stump on several occasions, and presume it is a customary method of leaving or entering their retreats. Twice I saw the weasel return, but in neither case did it bring any food with it, unless it was some object smaller than a mouse, nor was there any trace of fur or feathers about the entrance, although I am satisfied that this same pair had destroyed the ground-squirrels that a year previously had been so very abundant.

Ten days later, I concluded to dig out the nest, if possible, in order to destroy the litter of young it was supposed to contain, and thus prevent the serious raids which I feared would be made on my poultry.

The nest was scarcely two feet from the entrance on the hill-side, but was effectually protected by the large roots of the stump, behind some of which it was situated. It was lined with dead leaves, grass, and a few feathers of (I think) the robin and the chewink, and the skin of a snake, but no sign of the weasels was there. The nest had no odor about it, that I could detect, but my terrier evidently smelt something, for he dug about the stump, with great energy, for several days after I had completed my examinations. I discovered, soon after, that the weasels had, very shortly before I endeavored to dig them out, transferred their quarters to a rats' burrow under a pig-sty, not far off, and had made a radical change in their habits and diet, in so far as they now fed exclusively upon the rats in the neighborhood. There was found in their new quarters a large pile of rats' bones, and, as subsequent experience proved, these little weasels had effectually cleared the premises of that terrible pest. My dog, however, was constantly on the watch, and finally worried the weasels so that they again sought new quarters. In September, I found them once again, and this time they had made a new home under a large oak growing on the border of a meadow. Here they seemed to be living wholly upon crickets, frogs, and mice, particularly the pretty white-footed or smaller jumping mouse. The number of common black crickets and grasshoppers destroyed by them was enormous, and this fact went a great way toward recommending the animal as being really sometimes as beneficial as it was at others destructive. Certainly this one family of weasels did me no harm. They destroyed half a dozen young chickens, I know; but this is offset by ridding me of a plague of rats, at least for that year, and then of the grasshoppers that I have mentioned.

The care that had been exercised, in early summer, to prevent the discovery of their nest, was now abandoned. The ground in front of it, and but little less so all about the tree, was covered with the remains of the crickets and grasshoppers that swarmed in the surrounding meadows. My impression is, that the weasels were constantly on the alert for them, and seized every one that ventured upon the grass near the nest. That frogs had also largely been preyed upon was evident from the many bones that I subsequently found in and near the entrance to the nest.

While mice were the game which they appeared regularly to hunt, one species proved not at all easy of capture, unless when surprised. This was the jumping mouse, or jerboa. Quite late in the month (September) I was intensely interested in seeing my weasels once more, under quite different circumstances. While standing on the border of a wide stretch of meadow, the grass on which had lately been mown, I saw a jumping-mouse give an enormous leap, and no sooner had it touched the ground than it leaped a second time, with even greater energy, but not in the same direction. For some reason it had turned about, and in leaping returned very nearly to the spot from which it had first jumped. Its unusual actions had roused my curiosity, and, going quickly toward it, I was surprised to see a little weasel bound nimbly, in its peculiar manner, over the grass. As it turned out, there were three of these animals, near each other, and undoubtedly associated together in the hunt. One of them had flushed the mouse, which literally came very near jumping into the jaws of a second, and had I not disturbed them, it would probably have been seized on touching the ground, after its second leap, as one of the weasels was very near the spot where it alighted. On my remaining quiet, the weasels resumed their hunt, and one, or the three in concert, flushed the mouse several times, before it reached the thicket near by, which I hope, at least, afforded it security against their tireless persecution.

This incident, and my impressions from the little I have observed of the larger weasel or ermine, convince me that during autumn and winter the families remain together. If this is not true of weasels in wilder and uncultivated regions, is it a habit lately acquired by those that live in the more thickly settled districts, being found conducive to their safety?

CHAPTER IV.

OUR COMMON MINK.

So familiar is the common mink to every one who has lived in the country, and so minutely have its habits been described, that nothing can be added to our knowledge of the animal. My field-notes are filled with brief references to it, and I find that twenty years have come and gone since first I saw a living specimen. This first experience was very memorable, and is even yet always recalled, whenever, as I float leisurely down the creek, on the lookout for fish or birds, I happen to catch a glimpse of a stray mink, as it runs along the shore in quest of fish, flesh, or fowl, as the case may be. I seem to witness the struggle all over again, and need no reference to my notes to refresh my memory, though, to insure greater accuracy, I will transcribe them: "Cold, raw day, for the second week in May (1860), but, in spite of the threatening sky, went down to Watson's Creek to look for warblers. Saw nothing but yellow-rumped warblers (*Sylvicola coronata*), and only a few of them, and a single listless red-start (*Setophaga ruticilla*), that evidently wished itself in the sunny South again. Near the 'big ditch,' although I was a long way off, I saw something moving in a seemingly rough-and-tumble fashion, so I hurried on. It proved to be a good-sized 'snapper' (*Chelydra serpentina*) having a tussle with a mink. The turtle had the mink by one hind-leg, and held on like grim death, while the mink had its jaws buried in the snapper's throat, and it, too, held on, although the snapper kept his head moving in and out, all the time, in such a way that the back of the mink's head was being rubbed against the edge of the top shell, and was now all raw and bleeding. The snapper was making for the ditch, twenty yards off, but moved pretty slowly. I took hold of him by the tail, and, holding him up, put my foot on the mink and pulled hard. It was no use. Neither let go, and it was a question of the turtle's tail or the mink's leg. Then I tried poking the snapper with my cane, and finally he gave a snap at the stick, but was too much encumbered by the mink's clutch of his throat to seize it. The mink, however, didn't mean to let go, for, when I held the turtle well up from the ground, it still held on, dangling in the air, and apparently dead. A smart rap on the head, while swinging in the air, made him let go at last; but the broken leg and loss of blood had used him up, and he lay on the ground, not dead, but dying." This is my "note" of more than twenty years ago. It is among the first of my field-notes, and I let it stand, as I wrote it, while rambling about Crosswicks meadows. Ever since I have admired the pluck of the mink, for here was a case where, for a considerable time, under the most painful circumstances, with its body describing a nearly complete circle, it had firmly maintained its grip, determined to sell its life as dearly as possible.

That the mink has been able to hold its own, even in thickly-settled districts, is due to the fact that it possesses advantages which have enabled it to elude the persecution to which, at times, all our mammals are subjected. Among these are an acute sense of smell, so that it can scent danger from afar, and a high rate of speed when chased "in the open." Like the little weasel, it can also hide in a marvelously small space. In fact, everything is so favorable to it that it has learned no tricks, and resorts to no stratagem when it finds itself at close quarters with an enemy. It has, also, in common with the otter and the musk-rat, the advantage of being as much at home in the water as on the land; and hence it largely frequents those irreclaimable tracts of marsh and swamp that, being useless to man, are but little frequented by him. Still, the mink has suffered more than most animals from the attentions of the professional trapper.

Whenever I have seen a mink, in my meadow rambles, I have been impressed with the fact that all animals that fear man are as much on the lookout for him, and try as sedulously to avoid him, as they do any of their natural enemies. This fear of enemies I believe to be ever uppermost in the minds of animals; and possibly the mink considers man an enemy to be shunned just as decidedly as the toad shuns the snake. If, then, animals entertain this dread of man at all times, is it at all strange that we so seldom see them when we go bungling about their haunts? We probably never take a walk in the woods that we are not watched by many creatures which we do not see; and many a squeak or whistle, which, if we heard at all, is attributed to some bird, is a signal-cry of danger made by some one animal, which, having seen us, takes this method of warning its fellows. Even the little white-footed mouse can squeak so shrilly as to be heard several yards; and the bark of the gray squirrel is a far-reaching note. The little ground-squirrel, or chipmunk, can whistle a single note of warning, that scarcely differs from the clear notes of the crested titmouse.

I have more than once tested this in the case of the mink. Mooring my boat near where I had reason to believe these animals had their nests, and remaining perfectly quiet and in hiding, I have usually been rewarded by seeing the minks moving about as soon as their confidence was restored by the absence of all signs of life in or about the boat. They would come out of their burrows, or from under large roots, and dive into the water, or it might be that they carried some food from the shore to their retreat. Any act of this kind, free from the restraint of fear, is in the case of all animals the most interesting and instructive, and, were our opportunities of this kind more frequent, our knowledge of animal life would soon be largely increased. Important as it is to measure their bones and count their teeth, most of the great problems of biology can, after all, only be solved by careful study of animal life in its native haunts, and in an environment not essentially influenced by the presence of man.

A few words as to the animals upon which the mink preys. While from its quick movements and weasel-like capability of stealing quickly along through tall grass, without adding a tremor to a blade, the mink has everything in its favor, it limits its attacks to those birds that are not capable of serious resistance. In August, when the marsh-meadows are teeming with the sora-rail, the minks have a jolly time, and capture hundreds of them, in spite of the speed at which these birds can run, and of their moderate power of flight. In early summer minks destroy many young ducks by seizing them by the feet and drowning them, as does the musk-rat, the snapping-turtle, and, as claimed by some, even the big bull-frog. But when it comes to attacking the herons and bitterns, except perhaps the least bittern, it is a question whether the mink would not be at a serious disadvantage in approaching them. Unless they could seize these tall birds by the throat, which would not be easily accomplished, they would be certain to receive, in return for their audacity, a fatal stab from the beak of the bird. Over-confident spaniels that have been sent to retrieve disabled herons have been fatally injured, and why a like result should not occur when an uninjured bird is attacked I can not imagine. Judging from a little experience of my own with a wounded bittern, I should say the nimbleness of the mink would not avail it very much.

Besides birds and fish, minks devour a miscellaneous mass of animal matter. Much of this is carried to the entrance of their nests and eaten at leisure. In one instance I counted fragments of what I believe to be over three hundred cray-fish, besides bones of fishes in abundance, and the shells also of three painted turtles. The latter were probably dead when found by the minks.

While occasional fights doubtless occur between musk-rats and minks, in consequence of their usually living close together, I never had any reason to consider them as "natural enemies," and as being forever at war. Statements to this effect have frequently been made, but such has not been the result of my own observation.

CHAPTER V.

THE SKUNK.

If happily we can make our observations unseen by the animal, we can not but admire the beauty of the markings and general "make-up" of this handsome mammal; but, even under the most favorable circumstances, much caution is desirable on the part of the observer, for too great eagerness may result in vexing the animal, and thus destroying the balmy freshness of the sweet June woods.

Although seldom seen at present, in comparison with fifty years ago, skunks are probably less rare than they are supposed to be. In thickly-settled districts, however, they have become more wary on account of their persecution by dogs, and in such localities, I believe, become strictly nocturnal in their habits. While disclaiming any particular predilection for the animal, I must admit that I like them, and when an opportunity offers to follow one up I always do so with a feeling of interest, all the greater, perhaps, from the danger that attends the investigation, though, as yet, I have never met with an accident.

I am disposed to pay them a high compliment at the outset, for, from my observations of a dozen or more during the last twenty years, I credit them with being as cunning as foxes. This is at variance with the observations of naturalists generally, but here I am speaking of the few that linger in a thickly-settled locality. But of this hereafter.

In his notes on the skunk, written in 1748, Kalm makes one statement concerning them which is of considerable interest, if it be not an error. I refer to their ability to climb trees. He says: "It keeps its young one in holes in the ground and in hollow trees; for it does not confine itself to the ground, but climbs up trees with the greatest agility; it is a great enemy to birds, for it breaks their eggs and devours their young ones."

Now, Dr. Coues, recently, writing of these animals, remarks that they "neither climb trees nor swim in the water"; and again, he describes them as lacking "the scansorial ability of the martens." I can not speak of the skunks of 1748, but I am very sure that I have never seen one climbing a tree, or even resting among its branches; but that they have a trace of "scansorial ability" I can testify, for I have several times witnessed their walking—once running—on the top rail of a worm fence, and certainly this feat requires an amount of agility that would, I think, enable the animal to do a little climbing if the trunks of the trees were not perpendicular. Still, I have a Skye terrier that likewise runs on the top rail of fences with perfect ease, and yet he can not climb a tree. The difference between the two animals is to be found in the fact that the skunk climbs to the top of the fence, while the terrier jumps on it. But then comes the question, How does the skunk get into hay-mows if he can not climb? Surely he never would allow himself to be pitched in with the hay, in July, and be content to remain there quietly until winter, without giving the unlucky farmer cause to think that "somewhere near there be a pesky skoonk," as was once said to me.

But if not a good climber, or not a climber at all, the skunk can dig with marvelous ease, and in an incredibly short time it can bury itself deeply in the ground. Late in the autumn of last year (1881) I chanced to overtake one of these creatures in an open meadow. On discovering my approach, the animal started off on a brisk trot, heading for the nearest trees. I made no effort to overtake it, for obvious reasons, but kept the animal in sight. When it reached the edge of the meadow, where stood a clump of large trees, it immediately commenced digging with great rapidity, and in certainly *less than one minute* it had tunneled so far beneath the roots of one of the trees that I could not see it, although, of course, I was more cautious in my explorations than would be necessary with any other mammal.

This ability to tunnel in loose earth stands them well in need when they frequent thickly-settled neighborhoods, as they often make deep, temporary burrows in plowed fields, and find there a safe retreat during the day. As they can dig for themselves such an underground shelter as they need in a few moments, of course it is occupied but for a few hours. At night they are abroad in search of food, and, let them be where they may at daybreak, they can conceal themselves in a few moments so effectually that their whereabouts is not suspected. This, I believe, is the secret of their survival in the immediate vicinity of our towns. Had they only elaborate burrows to which, week after week, they resorted, then, doubtless, they would soon be discovered and driven off or destroyed. When the ground is loose or newly plowed, the skunk also resorts to digging to escape pursuit. I have knowledge of one instance in which the animal buried itself so quickly as to escape, although hard pressed. Then it did not throw out the dirt behind it as it progressed, but wormed itself through the loose earth much as a mole does. I subsequently determined that the skunk, in this case, reached a depth of two feet and tunneled a distance of nearly twenty It then turned about, and four hours later came to the surface within a few inches of where it entered the ground. When pursued by dogs, however, they do not trust to digging alone, but they endeavor to avoid an encounter by throwing the dog off the scent, and to do this they will pass along the top rail of a fence. If this fails, then their peculiar powers are brought into play.

I believe that this animal has learned the wisdom of avoiding the use of its peculiar means of defense when other avenues of escape are open, as it seems to know, possibly through "inherited experiences," that this discharge, while driving off one enemy, will attract a dozen others. Certainly, it is as much annoyed by the fearful stench as the unfortunate recipient of the discharge, and it must know, if it has any trace of intelligence, that dogs from every quarter will be attracted, not by the sweet savor thereof, but by the fact that the animal that originates this "atmospheric disturbance" is somewhere in the vicinity.

From a series of observations made in 1872, I am disposed to believe that the skunk discharges the defensive glands, when distended, in holes which it digs for the purpose and then covers over. This is a matter of prudence, comfort, and cleanliness to them, as it renders them less liable to be persecuted by dogs; and their nests and haunts during the early summer, when they have their offspring to look after, are much less offensive. Indeed, a nest of skunks is no more offensive to me than that of the mink or weasel. Whether the care exhibited by them in keeping their homes clean and comparatively odorless is due to their own dislike of the smell of their offensive discharges, or is simply a measure of precaution, the fact remains that such homes are often in frequented spots, and the presence of the animal is not suspected. Remaining carefully concealed throughout the day, and using great caution in their wandering at night, they escape notice, and are thus able to rear their young in safety.

While not exhibiting the aversion to water that characterizes our common cats, the skunk does not appear to take to swimming voluntarily, even when closely pursued. Thus, when trying to evade an enemy, if it comes to the bank of a pond or creek, it will usually turn from its course, and seek safety in some other way than by flight. Occasionally, however, in the upper valley of the Delaware, where these animals are much more abundant than in the southern or tide-water portion of the State, the heavy freshets of early spring will catch them napping, and then they are forced to seek safety by clinging to floating logs. In this position they take an unwilling ride often of many miles, and if luckily they escape drowning, it is only to find themselves landed in a level, scantily-wooded country, the very opposite in all respects to their original home.

Here it may not be inopportune to add that when, as has frequently happened, a skunk, an opossum, and several musk-rats seek safety, at the same time, from a sudden flood, and they all take refuge on the same log, there is no visible commotion or disturbance among them, though the wide berth given the skunk warrants the belief that all our mammals have a wholesome dread of the possible exercise of his peculiar method of defense. My impression, however, is that, when skunks are fighting among themselves, or contending with minks or opossums, as sometimes happens, over some hapless chicken, the use of their defensive and offensive glands is not brought into play as is the case when they are brought to bay or seized by a dog or man. Skunks, however, had this power before they were exposed to the attacks of men and dogs, and, if not used as a means of offense when among mammals smaller than themselves, it was acquired as the necessary safeguard against their dog-like enemies, the wolves and foxes.

When their involuntary river-voyages are undertaken, it often happens that a short swim becomes necessary. This is always so clumsily done that, if a skunk has more than a few yards to go, it will probably be drowned. They are not equally averse, I find, to traveling on ice; and the last living skunk I saw was walking on the ice from a small wooded island in Watson's Creek to the main shore. While inactive and prone to long naps in extreme winter weather, the skunk can hardly be considered as hibernating.

Skunks are very partial to snakes as an article of food, though insects, with frogs and birds' eggs, seem to be their main support. Were they under all circumstances odorless and quite harmless, their eager search for these latter articles is sufficient to condemn them. It is bad enough that the demands of science should seem to require the collection in a systematic manner of an occasional nest and complement of eggs. This can not be avoided; but to aggravate the evil by having a skunk destroy most of the ground-nests in the neighborhood is beyond all endurance. Better, surely, a nest of thrushes or song-sparrows than a litter of skunks. An animal that destroys birds' nests is always a nuisance, though I do not object to any other, however wicked. But to return to the snakes. When pressed by hunger, and hunting by daylight, the skunk prefers to go after snakes rather than frogs, or to risking itself within the precincts of the poultry-yard. Indeed, small snakes are evidently a great dainty, and the skunk appears to be more active when he finds a garter-snake, blind-worm, or flat-head adder, than at any other time. Having discovered a snake, he rises upon his hind-feet, and, giving a bear-like apology for a dance, he endeavors to seize the snake by the tail. If successful, he shakes the snake vigorously, as a dog would do, and seizing it, when dead or nearly so, near the middle of the body, he carries it off to his burrow, or to a hollow log, or to whatever shelter he has at the time.

In June, 1863, I witnessed a terrific combat between a large skunk and a black snake, which, I judge, measured fully five feet in length. The prowling skunk had evidently seized the snake by the tail, and endeavored to give it a violent shake, as it would a little garter-snake. This angered the snake, and, turning like lightning, he wrapped himself about the skunk, completely encircling both neck and body. The head was so far free that the skunk could give the snake nip after nip, though it could not get a strong enough hold to disable it. Rolling over and over, hissing and snapping, the snake nearly concealed by the long hair of the skunk, the two creatures presented a strange spectacle as they struggled, the one to conquer, the other to escape. After watching them for fully five minutes, I ventured to approach, and dealt the two a hard blow with a club, and then ran back a few paces, not knowing what might be the result. Turning about, I ventured to return part of the way to see whether the struggle continued. All was comparatively quiet, and, coming still nearer, I found that the snake had relinquished its hold and was slowly retiring in a disabled condition. The skunk was lying quite motionless, and proved to be dying, though not dead. Soon after, I examined the animal carefully, and found that it had been strangled, or nearly so.

During this combat there was no discharge of the defensive glands of the skunk. Whether these were inactive at the time, or whether they were disabled by the snake's attack, can not, of course, be determined.

An able critic suggests that the above incident had better be omitted, as a black snake has no such constricting power as is there implied.

While this snake always seizes its prey with its mouth, and never attempts, boa-constrictor-like, to suffocate it, I have abundantly satisfied myself that it can cling sufficiently tightly to an object to produce suffocation, if the animal is small. The grip that it secures about the limb of a tree, and which visibly tightens when you attempt to unwrap the animal, assures me that a similar hold upon an animal's neck would be sufficient to at least very materially affect its breathing.

CHAPTER VI.

THE OTTER.

Otters are now so seldom seen, even along Crosswicks Creek, that it may be counted a piece of great good luck to meet with one in the course of a day's ramble. I feel repaid for the exertion of a ten-mile tramp if one crosses my path, or if I catch a glimpse of one as it dives into the stream. Not much to be learned, I grant, from such a brief acquaintance; but there is, at least, the satisfaction of knowing that otters are about; and then it becomes our business to find them, not for them to make an exhibition of themselves, or publish the whereabouts of their chosen haunts.

Though these animals are now quite rare, it has not been many years since they were comparatively abundant. Local history informs us that they were formerly to be found in Crosswicks Creek, and in my mucky meadows even, in great numbers, and it has preserved the details of certain wonderful hunts in which a dozen or more pelts were secured in one day. "My four otter-skin lap-robes and my otter-skin great-coat" are items in the will of one who lived near by, less than half a century ago. There are even old trappers still living who formerly depended upon otter-skins as the main source of their profit in a winter's trapping. So much for the irrecoverable past!

My notes make mention of a sunny day in June, 1869, when I happened to wander to a wild spot some four miles away, on the muddy, sloping banks of a tideless stream. Here I took my stand, and in the dense shadow of the overhanging trees began my observations on the owls and jays that were, as I thought, my only companions. Soon, however, I found out my mistake, as a loud splash notified me of the presence of other company. It was an otter, and, as my approach had not been seen and I stood motionless for some minutes after hearing the splash, I was duly rewarded for my prudence and patience by seeing the animal slowly emerge from the glassy surface of the pond, holding a large fish in his mouth. With awkward steps he crawled up the opposite bank, and in a marvelously short time he devoured the fish, or most of it. Then walking to a point beyond, but in full view, he squatted down until his belly rested on the muddy slope, and, holding his head well up, with an expression of extreme satisfaction, he slowly slid down the smooth bank and disappeared beneath the surface of the water.

I waited a full hour, but he did not reappear. Since then I have but seldom seen living otters. Once I overtook a large one, that at first "showed fight." It was in a small but dense huckleberry-swamp without water enough for a comfortable bath. To find these animals thus, away from deep ponds and running streams, is a rare occurrence. Their main food-supply is fish, and what substitute they find in swamps I can not say, unless it be the innumerable frogs that abound in such localities.

I have never been able to determine positively what sounds and cries, if any, are made by this animal. Although my opportunities for studying their habits have been very few, I have always had this matter in mind whenever I have chanced to catch a glimpse of them.

From a single occurrence, I am disposed to believe that they have what we may call a whistle, or whistle-like scream, uttered occasionally when several of them are met together. My reasons for thinking so are founded upon an incident that happened several years ago. While bobbing for eels in Watson's Creek, near by, one pleasant moonlight night in August, my attention was drawn to a commotion in the water, about fifty yards distant. I quickly raised the "bob," and gave my whole attention to the splashing and dashing, which were evidently caused by some three or four animals of large size. What they were I could not positively determine; but they were evidently too large for minks, and I could hardly believe that they were musk-rats. The clear light of the harvest moon, however, enabled me to see that mammals of some kind were either fighting or playing on and about a half-sunken log, one portion of which projected a short distance above the surface of the water. At three different times, one, and, as it seemed, the largest of these animals was alone upon the projecting portion of the log, the others at the time being nowhere visible. At each time that this unknown creature was thus alone, it uttered a peculiar cry or call, which may be described as commencing with a low whistle and ending with a hiss. The sound was unlike anything that I had ever heard, and, while somewhat cat-like, would never be mistaken for the cry of that animal. Each time the animal made this sound, it appeared to raise itself on its hind-feet and then dived, when almost immediately the other two or three appeared and mounted the log. There was not sufficient light for me to determine anything positively, but I have always believed that the animals I saw and heard were a female otter and her young.

The last otter that I saw alive was in February, 1874.

In the same stream where, thirteen years before, I saw the supposed otter and her young, amid cakes of floating ice, during a freshet, I saw a very large otter come to the surface with a chub in its mouth. It seemed quite at home in the icy waters, but dived immediately when it saw me. Soon, however, it reappeared far out in the stream, and clambering on a cake of ice it drifted slowly outward "to join the brimming river."

I sought to drive it from this stand, by shouting and throwing snow-balls; but it evidently knew that I could do it no harm at that distance, and it appeared to watch me with sublime indifference as it slowly floated seaward on the trembling raft of ice.

This otter was much of the time within easy range, had I had a gun or rifle; but the animal seemed to know that I was unarmed. At all events, it showed no such fear as animals usually do when a hunter is about. It may be a mere coincidence, I know, but for many years I have noticed that I invariably have better luck in seeing mammals and birds when I go into the fields unarmed than when I have my gun with me. It is certainly true that crows know a gun when they see it, and may it not be that among our large mammals this knowledge obtains also?

Kalm does not make much mention of the otter, although seen by him frequently. His one brief remark concerning them refers to the ease with which they can be tamed and trained. He says: "Beavers have been so tamed that they have gone out fishing, and brought home what they had caught to their masters. This often is the case with *otters*, of which I have seen some which were as tame as dogs, and followed their masters wherever they went; if he went into a boat, the otter went with him, jumped into the water, and after a while came up with a fish." This, alas! is something of the past, and no recent attempts to train otters have been made in my neighborhood. The nearest approach to it was an effort simply to tame a half-grown specimen, and this could scarcely be called a success, as the animal never would allow itself to be handled, but fought the dog and bit the tamer's wife—refused food, and died in less than a week.

CHAPTER VII.

THE FLYING-SQUIRREL.

About sunset, or even later, after nightfall, out there comes from some hidden hollow in the trees, with a joyous bound, our merry-hearted pet—the flying-squirrel—and, hastening to the outermost branch of his home-tree, he literally spreads his wings and sails through the air from tree to tree, on and on, through the depths of the woods.

But not alone is he when thus on his nightly travels. Another and another of his kin come from the same hollow in the tree, and young and old traverse in like manner some well-known tree-top route in search of their daily food. Often they do not return until morning, unless it is very dark, and then they soon return by the same route, chattering like school-girls as they pass with marvelous expedition from tree to tree. It must not, however, be supposed that they promptly retire for the remainder of the night, even when they happen to come home early. Very far from it. Their jaunt seems only to have stretched their limbs and given them a taste for the frolic among the upper branches of the trees, and is really indescribable. It would be hard enough to give the details of these movements even if plainly seen in broad day. Such a chance, however, seldom or never occurs, and the little I have seen of them has been by stray glimpses caught during clear moonlit nights. Unsatisfactory as these opportunities have been, they fully convinced me that the scansorial abilities of these animals are quite equal to those of the common gray squirrel, and they have also shown me that for hours these little squirrels will clamber and jump from limb to limb of the same tree, without calling into play their flight-power.

When disturbed during the day, unless hurt, they are for a considerable time as stupid as owls, probably because "their large eyes, like those of the owl, can not meet the glare of the sun." In time, however, even though the day be very bright, they seem to realize the situation, and then, if on the ground, they scamper off with an easy but not graceful gait; but if they happen to be in a tree among trees, then they use their "wings." Never have I seen them, on being disturbed, make any effort to conceal themselves, which they might easily do; more readily, indeed, being smaller, than the gray squirrel, which appears always to elude pursuit by an effort to conceal itself, and only to run away when it finds that its previous effort at hiding has failed. That the flying-squirrel should not adopt a similar mode of seeking safety when pursued has ever been a mystery to me.

From numerous experiments and many observations, I am satisfied that the flight-power of this squirrel enables it to preserve a horizontal position of several feet —ten or twelve—before the downward glide commences; but the membrane once expanded, is not apparently moved in any manner until the animal draws in its feet to seize hold of the branch it has reached. A movement of the membrane that gave the squirrel an additional impulse has been asserted of this animal, and the suggestion made that the first steps toward the acquirement of the flight-power of the bats had been taken. This I will not deny. It is something for which I have looked for many years, but have never as yet seen any evidence of it. I am glad that others have been more successful.

When a flight is about to be taken, the body is drawn up until nearly globular in shape, and then the membrane is again expanded simultaneously with the impetus given to the body by the powerful hind-legs. If "wingless," this squirrel would move quite similarly to the jumping-mouse (*Jaculus*), or even the better known white-footed or deer mouse (*Hesperomys*).

In a recent publication I find it stated that these squirrels fly "smoothly and swiftly on an inclined air-plane for thirty, forty, even fifty yards." This I consider an exaggeration. It is perhaps within bounds to say that this animal can sail down an "inclined air-plane" for thirty yards; but it is very rarely that they do so, and I believe this distance is never exceeded. Their ordinary flights are about five to ten yards in length; a distance that the common gray squirrel will clear at a single leap.

It is highly improbable that these squirrels would tarry long in a locality where the trees were so scattered as to require longer flights. In fact, it is with flying-squirrels, as with all creatures possessing some well-marked peculiarity: the earliest accounts of the peculiarity are exaggerated, and the inherent love of the marvelous in man subsequently prevents for a long time a correct view of the matter being acquired.

A word more concerning this habit of flying. I have twice met with individuals of this species that were apparently partial reversions to the ancestral non-flying squirrel. The membrane extending from the fore to the hind limbs, that acts as wings, was scarcely developed, and the fore limbs were somewhat stouter than in the normal condition. In their movements, these squirrels were more like the true *Sciuridæ*, but, being associated with their own kind, they tried to keep up with them and "fly," but the most that they could do was to execute a very graceful *dive.* These two non-flying squirrels were both adults when captured, but died in a few days after being caged.

Years of familiar acquaintance with these squirrels have not enabled me to detect much in their habits indicative of intelligence; and it is for this principally that I look in studying animal life. I feel sorry to have so poor an account to give of these beautiful creatures, but I am compelled to say it of them—they are not "smart." Notwithstanding all their vivacity when in their native haunts, and their eminently gregarious habits, they do not suggest by any of their movements, so far as I could ever detect, any decided indication of that sociability characteristic of the ground-squirrels or chipmunks (*Tamias*). Each, on the contrary, jumps, runs, flies, solely on his own account, associated together indeed, but never acting in concert. Their several squeaky cries, too, are quite as frequent when they are alone as when associated with their fellows. Thus, they are really devoid, to me at least, of the most attractive features of animal life.

Flying-squirrels do not pass into a prolonged hibernating sleep, with the regularity characteristic of some other mammals. They store up a goodly quantity of nuts and acorns, which are stowed away in a hollow of some large tree; and from this magazine they draw their rations pretty regularly, unless the weather should be intensely cold. Even when snow covers the ground they sometimes leave their nests, for I have often caught them, in January, in an ordinary box-trap set for rabbits.

Their nests are often in one tree, while their food-supply is stored in another near by. The nests are always abundantly supplied with soft materials, and sometimes as many as a dozen squirrels will take up their winter abode in one. When asleep, they appear like little furry balls, so arranged that the tail is made to do duty both as a pillow and coverlet; the head rests near the base of the tail, which is spread over that side of the body which happens to be uppermost.

These squirrels have of late availed themselves of conveniences erected by man, which partially replace the heavy growths of timber that have so generally been cut down. They now take up their abode in the attics of houses, if they can find any means of entrance. Once established, they drive the mice away, but they are themselves so noisy that the change seldom proves desirable. If the locality does not meet with their approbation, they not only ramble noisily wherever they can get, but quarrel incessantly. In out-buildings, also, I have frequently found them wintering. If the nest is in hay or straw, they nibble out a circular shaft or tunnel leading to it, and carry in an abundant supply of grain, if such can be had. In this regard, they are but little, if any, less destructive than rats or mice.

To return to the woods. Flying-squirrels make very large nests of leaves high up in the tallest trees, which are in every particular the same as the leaf-nests of the common gray squirrel. Some of those that I have examined appeared to be sufficiently compact to withstand the winter storms, and were warm enough to protect the squirrels during the coldest weather. In them, however, there were no stores of nuts and seeds, so either the occupants hibernated the winter through and needed no food, or they had magazines near by, to which they resorted during spells of mild weather.

Flying-squirrels are now, in consequence of the general destruction of the heavier growths of timber, not numerous, and it is probable that they never were as abundant as the other species of *Sciuridæ*. Even so long ago as 1749, Kalm refers to them as "met with in the woods, but not very frequently"; and again, that they "are so tamed by the boys that they sit on their shoulders and follow them everywhere."

Gabriel Thomas refers to these animals, in his quaint little history of New Jersey, as follows: "There is also that Remarkable Creature the *Flying Squirrel*, having a kind of Skinny Wings, almost like those of the *Batt*, though it hath the like Hair and Colour of the Common *Squirrel*, but is much less in *Bodily Substance;* I have (myself) seen it fly from one Tree to another in the Woods, but how long it can maintain its Flight is not yet exactly known."

The most interesting feature connected with the flying-squirrels of this neighborhood is, I think, the fact that they are slowly adapting themselves to an altered environment, as shown by their constructing nests of leaves, which probably, a century ago, they did not do; and by their willingness, so to speak, to occupy accessible nooks in the dwelling-houses to which they can gain access from tall trees growing sufficiently near to enable them to reach these artificial quarters by means of their limited flight-power. I believe these squirrels never take journeys, however short, by simply running on the ground. Unless they can pass from tree to tree they stay at home.

This pretty mammal figures, I find, in American animal weather-lore, but not to any important extent. In "Signal-Service Notes," No. IX, the compiler of that interesting volume writes, "When the flying-squirrels sing in midwinter, it indicates an early spring." As a lover of early spring, I heartily wish this were true. Examining the matter more closely, it will be found that pleasant weather in midwinter, when squirrels rouse from their prolonged sleeping, is usually followed by late springs; a record of the past one hundred winters showing clearly that the more uniformly cold winter is, the sooner and more evenly spring commences. If, therefore, these singing-squirrels could be relied upon, it would be as bearers of unwelcome news—that spring would be tardy in arriving. It is scarcely necessary to add that all such "sayings," so far as based upon the habits of animals, are, as yet, valueless to the student of meteorological science.

CHAPTER VIII.

THE CHIPMUNK.

With the first sweet blossoms of the *Epigæa*, and long before the foremost warbler greets his old-time home with gleesome songs, our little chipmunk has roused himself from his long winter's nap, and sniffing the south wind, as it whirls the dead leaves about, scampers to and fro while the sun shines, and dives into his winter quarters, it may be for a whole week, if the north wind whispers to the tall beech-trees. But, in due time, the blustering days of March give way to showery April, and then, with more courage, "Chip" faces the music of the winds, let them blow as they list, and, darting along the top rail of our zigzag fences, he chatters and scolds, and calls to his equally noisy companions. They know full well that they have the summer before them, and, while determined to enjoy it, they begin early and in good earnest to make arrangements for its coming duties. I watched several pairs of them from March to November, in 1874, and nearly all of my observations were made at this time, as other mammals have occupied my attention since then.

Until the weather became fairly settled and really spring-like in character, these little chipmunks did not often show themselves, and when they did it was only in the middle of the day. They appeared to foresee the occurrence of a cold rain some twenty-four hours in advance and resumed their hibernating slumbers, becoming lethargic and very difficult to arouse. A pair that I dug out in March, having two days before re-entered their winter quarters and become quite torpid, were apparently lifeless when first taken up in the hands, and it was not until after several hours' warming that they became lively, and altogether like themselves. This seemed to me the more curious, in that they can respond to a favorable change in the weather in a short time, even when the thermometric change is really but a few degrees.

On the 3d of May a pair of chipmunks made their appearance in the yard of my home, and took up their abode in a stone wall with a southern outlook, on the brow of a steep descent of over seventy feet. This hillside or terrace-front is thickly wooded, and harbors scores of these creatures, as well as many other small mammals. From the fact that the subterranean homes of these animals are said to be quite elaborate in structure, I determined to wait until the pair in the yard had completed their excavations in and under the stone wall, and arranged their nest, and then to open and expose the nest and its approaches of another pair, which was more accessible, and commenced at the same time. This I did on May 29th, and without difficulty determined the general character of the nest and its two entrances. The burrow contained five young, about three days old. The two entrances were at the foot of a large beech-tree, standing about six feet from the brow of the hill. A little grass only grew about the tree, and the holes at the surface of the ground were very conspicuous. No attempt at concealment had been made; but this was evidently because there were here, at this time, but few of their many enemies. Indeed, I was inclined to believe that there were no weasels about, and these are the most destructive of all their enemies. The little weasel, perhaps, is less prone to enter their nests than the ermine; and it is the former species which is the more frequent of the two in this immediate neighborhood; but if the little weasels chance to take up their abode near by, the chipmunks soon hie themselves off to "fresh fields and pastures new." To return to the chipmunk's nest. The right-hand entrance to the nest proper was nine feet distant from the opening at the foot of the tree, but, as the passage had a somewhat tortuous course, the tunnel was really about twelve feet long. The nest proper was, as near as I could determine, about twenty inches in length, and perhaps a foot in height. It was lined with fine grass. I had hoped to find more than two passages to the nest, and extra cavities or granaries, but there were no traces of them. These supplementary burrowings, or "store-houses," I believe now are made quite late in the summer, and are additions to their main burrows, made when it becomes necessary for them to commence storing up their winter supply of food.

One feature of this earth-nest, and of all underground retreats of our mammals, struck me as very curious. There was no evidence of any caving of the earth that I could see, or could I detect any evidence that means had been taken to prevent such an occurrence. The soil where I exposed the nest of the chipmunks was a fine, ferruginous sand that caved in whenever I tried to construct a similar tunnel. I made such examination of the surface of the burrow as I could, and found no trace of any foreign substance that explained the mystery, for such it was and is to me.

On the 23d of June six young chipmunks made their appearance about the stone wall in the yard, and to these, with their parents, I will now confine my attention. It puzzles me even now, when I think of it, to imagine when this family of eight chatter-boxes took any rest or kept moderately quiet. Very frequently during *that* summer (very seldom since) I was astir at sunrise, and I always found that these chipmunks were already on the go, and throughout July they appeared to do little but play in a very animated sort of way. They seemed to be playing at what children know as "tag"—i. e., they chased each other to and fro in a wild, madcap fashion, and tried to touch or catch one another, and sometimes to bite one another's tails. Occasionally the tail of some laggard gets a nip, and he gives a pitiful squeal, which starts them all to chattering. The way in which they scamper along the tapering points of a paling fence is simply astonishing; but, however mad may be their galloping, let a hawk swoop down, or even pass over, and in a moment every one is motionless. If on a fence, they simply squat where they are, and trust to luck to escape being seen. If on the ground, when an enemy is discovered, and not too far from their underground nests, which is not often the case, unless foraging, they will dart to these nests with incredible swiftness, and going, I think, the whole length of the passage-way to the nest proper, they turn about immediately and retrace their steps to the entrance, from which they will peer out, and, when the danger is over, cautiously reappear and recommence their sports. These creatures, during the summer, play merely for play's sake, and seem to have no more important object in view than amusement. Indeed, so far as I have studied animal life, this indulgence in play, just as children play, and for the same reasons, is common to all animals. I have often seen most animated movements on the part of fishes that could, I think, be only referred to this cause. Frogs, perhaps, in this respect are the nearest to being old fogies, as I never could detect anything on their part that the most vivid imagination could construe into "having fun."

About August 15th these chipmunks, and all the others in the neighborhood, appeared to settle down to work in "real earnest." Instead of playful, careless creatures, living from hand to mouth, they became sober and seemed very busy. Instead of keeping comparatively near home, they wandered off quite a distance for them, and filling both cheek-pouches full of corn, or later in the year, with chincapins and acorns, home they would march, looking, in the face, like children with the mumps. How much they can carry at one time, in their cheek-pouches, I know, from actual measurement, but am afraid to say, as the statement would be "hard to swallow," and so the inquisitive reader may determine the matter to his own satisfaction.

This habit of storing up quantities of food against the coming winter was continued, in this case, and I suppose it is so generally, until the first heavy white frosts, when the chipmunks give up to a great degree their out-door life. The food thus gathered, usually nuts and corn, is, I believe, partly consumed when they go into winter quarters, and before they begin their hibernating sleep, which may not be for some time. This impression is based on the result of digging out a nest as late as the 3d of November. The last time I had seen a chipmunk belonging to this nest was October 22d. Twelve days after, I very carefully closed the three passages that led to it, and calculating about where the nest was, I dug down until I came upon it. I found four chipmunks very cozily fixed for winter, in a roomy compartment, and all of them thoroughly wide awake. Their store of provisions was in a smaller room or store-house immediately adjoining, and consisted wholly of chestnuts and acorns; and the shells of such of these nuts as had been eaten were all pushed into one of the passages, so that there might be no litter mingled with the soft materials that lined the nest. How long this underground life lasts, before hibernation really commences, it is difficult to determine; but as the torpid state does not continue until their food-supply is again obtainable out-of-doors, the chipmunks, no doubt, store away sufficient food for their needs throughout the early spring.

CHAPTER IX.

WILD-MICE.

I HAVE often felt sore because I could never find a shrew in any of my rambles. I have knocked over hundreds of mice, in hopes of finding one with a pointed snout and a slender tail, but all to no purpose. There are shrews in my meadows, I am confident. Indeed, others have found them; but in twenty years' search I have never seen one. But if not a shrew, I have seen mice in abundance—mice big and fat; mice lean and small, and middle-sized mice; mice that were ill-tempered and would bite; others that were gentle, and took pleasure in nestling in the hollow of your hand. Sometimes I would fill my pockets with them, or tie up a dozen in my handkerchief, and then, reaching home, would let them loose in a box, and sit down gravely to "determine the species." I would have De Kay's tomes before me, and Coues's and Allen's bulky quarto on "Rodentia," and Jordan's "Manual," and the mice, and I would work by the hour, and pinch their tails and squint at their teeth and twist their toes, but it mattered not, all my labor and all my specimens simmered down to one poor meadow-mouse. I have tried to twist their hair and curl their whiskers, and lengthen their ears by a sly pull with the tweezers, but it was of no avail—there was only the one species, and I could not make a second, although I have tried very hard and very often.

If, however, there is but the one mouse in our meadows, it is not so devoid of interest as might be thought, from the fact that it elicits generally no further remark than that "it is nothing but a meadow-mouse."

Let us see what constitutes a meadow-mouse. As a furry entity dwelling in a bunch of grass and living on the seeds thereof, he is monotony itself; but sometimes, as I have found, there is a variation from this prosaic style of keeping house, and then the despised meadow-mouse is a creature of decided interest.

For instance, I find in my note-books, under date of May 23, 1882, that in wandering along the margin of a low or "mucky" meadow, I came across a large but thoroughly rotted log. On giving the log a kick and a push with my cane, I saw that I had disturbed a whole host of creatures of various kinds. A meadow-mouse ran into the reeds near by, a swarm of black ants covered one end of the log, while untold thousands of red ants covered the other, and finally a white-footed mouse showed itself through a knot-hole and scampered off with a squeak. Seeing this much at a preliminary glance of the rotten log, I forthwith instituted a detailed examination, with the following results: Between the semi-detached bark and the log itself there was a neatly-made nest of long grasses occupied by the white-footed mice. There they resorted when not foraging, and had everything cozily arranged for future contingencies. I was very sorry that I had so rudely upset their plans, as Mrs. White-foot was evidently in an interesting condition. In the center of the decayed log, a family of meadow-mice had constructed a very elaborate home. There were three well-made tunnels leading to an interior chamber, which was of sufficient size to accommodate a dozen mice without crowding. This nest or "room" was partly filled with fine hay and a few very small feathers. There were no young mice, however. The three exits were of sufficient size to admit of the rapid passage of a mouse, say about one and a half inches in diameter. Although the wood was very rotten and yielded to the gentlest touch, yet the sides of these tunnels were beautifully intact and as smooth as a carefully bored hole in hard wood. While much interested in the fact that two very distinct species of mice should occupy quarters in such close proximity—the two nests being less than a foot apart—I was more struck with the fact that there should be also two colonies of ants in the same log. One colony of large black ants, nearly half an inch long, had an extensive series of tunnels, chambers, and anterooms built in one end of the log, and in some of the apartments were numbers of large white larvæ. The mice, both meadow and white-footed, were near at hand, all day and every night, and notwithstanding the tempting morsels in the shape of the larvæ I have mentioned, the mice did not appear to have disturbed the ants at all. On the other hand, the legions of black ants at one end of the log might readily have taken possession of the nests of the mice, yet I did not see a trace of an ant in either nest. Then, at the other end of the log, six feet away, were these minute red ants by millions. These might also have proved a formidable foe to the mice, yet they, too, seemed willing to remain within bounds, and not a sign of them was to be found in the nest of either species of mouse.

Some years ago a freshet floated a few half-rotted logs into a stretch of low, swampy meadow, near my house, and in these logs colonies of meadow-mice took up their abodes. They were regularly bored and tunneled, just as so much firm earth might have been. In each was a large central chamber or nest, thus showing an adaptation to circumstances which greatly interested me.

The food-supply in the meadow evidently was abundant, hence these mice remained; but the ground was too wet to admit of underground retreats, so these half-rotten logs had been utilized, and proved in every way adapted to their wants. I could not determine what constituted the food of these mice, but suppose it to have been, in part, seeds of the reeds and coarse grasses; and it is not improbable, when these were not obtainable, that they fed upon animal food. My attention was called to the probability of this, from the fact that at every low tide many very small fishes were left in little puddles, and as these nearly dried away before the tide returned, it was practicable for the mice to have caught these fishes. Although I have often watched for some evidence of this, I never saw a mouse go a-fishing; but then this proves nothing, for these meadow-mice are far more active by night than by day, and when I was away they could readily have caught an abundance of these fishes.

Unless the weather is extremely cold, the meadow-mice do not hibernate. They simply prepare for cold snaps by making roomy subterranean chambers, and line them with fine grasses. From these they sally forth at midday, if there is any sunshine, and find plenty of food in the seeds of the rank grass-growths that surround their chosen haunts. The food that they store for winter use is inconsiderable, and probably is consumed soon after it is placed in the magazines. Of course, I am speaking only of the mice as I have observed them in the neighboring meadows.

Of our few remaining mammals, perhaps none have suffered less from the encroachment of man than the beautiful white-footed mouse. The fact that this little creature is a mouse, and you can not make anything else out of it, is certainly very much to its disadvantage. Could we but call it by some other name, many would feel that interest in it which it really deserves. Being a mouse it is passed by all unheeded, or else cruelly pursued with all the alacrity that the good housewife displays in chasing down a too daring *Mus musculus.*

White-footed mice are nocturnal in their habits, but, like all the night-loving mammals, they are frequently astir during the day, and do not seem to be greatly inconvenienced by the glare of the midday sun.

In my neighborhood these mice are very abundant, and I have taken especial care to watch for them, and study their ways whenever I could, but in spite of all my efforts I never could detect any peculiarly interesting feature in their habits, or catch a glimpse of something I had not anticipated. Our knowledge of the habits of most of our mammals is still incomplete. Something novel may at any time be expected; but, lively and musical as is the white-footed mouse, it differs but little from the prosiest mouse in your cupboard, so far as its habits are concerned.

Nevertheless, their manner is attractive, and reminds one of a flying-squirrel, perhaps, more than anything nearer akin to it. When the nest is built in a tangled thicket of briers, as is sometimes the case, or the animal has chanced to occupy an old bird's nest, little white-foot clambers about these briers with astonishing ease. How it escapes the thorns, I can not imagine. Having found a nest, an excellent method of making them display their scansorial ability is to quietly place a dead snake near by, and then give the mice a shaking up. The moment they spy that snake, they leave for parts unknown with such alacrity that even the direction they take can not always be satisfactorily ascertained. Leaving the dead snake, however, does not prevent their return, for soon they will come creeping cautiously along the briers, as slowly as possible, and evidently reconnoitring. If they are satisfied that the snake is motionless, they will creep very near, thus braving a great deal, especially if their nest contains young. Perhaps half an hour may pass, but they gradually determine that the snake is dead, and then they slip cautiously back to their nest. If the snake is left, their fear wholly vanishes by the next day; and the chances are, if you revisit the nest, you will see them dining off the reptile.

In autumn, white-footed mice store up nearly as great a bulk of nuts and grain as the chipmunk, and build cozy nests near these magazines. Usually there is an underground passage connecting the two, unless the nest is under a log or stump. During winter these mice take very protracted naps; but they are supposed not to hibernate. Now the distinction between sleeping, often over a period of four weeks, without once awaking, and true hibernation, is one that I fail to comprehend. Notwithstanding the very extensive magazines filled with choice food, gathered by these mice, they do not make any marked inroad upon them during the winter, and so, if much of the time awake, they must have but very poor appetites. Time and again I have opened their granaries in February and March, and found them nearly or quite undisturbed. Perhaps they had other stores of food, which had been opened during the winter, but I think not; and I know very well that these mice are nearly twice as heavy in May as in March, when "they are poor as snakes."

If the weather be warm, about April 1st they are fully themselves again, and ready to commence their round of summer life with all the responsibilities that "housekeeping" entails; and then it is, after a long season of comparative fasting, when the supply is scarcest, that they have need of food, and, in order to recruit their energies, I have found that this mouse has decided carnivorous habits. While by no means as bloody as a weasel, or fierce as a brown rat, it nevertheless does not hesitate to attack a weaker brother, and it is really a skillful hunter of birds' nests, the contents of which, whether eggs or young, it feasts upon with great relish. Several times I have known them to rob the nests of robins, song-sparrows, and the chewink or swamp-robin. In one instance, a brood of young robins, nearly old enough to leave the nest, were attacked by a pair of these mice, during the brief absence of the parent birds, and two of them were killed. Carefully keeping watch, I found that as soon as the old birds retired from the nest, to answer the calls of two of the young birds which were on the ground, the mice stole back to the nest and began eating the young birds they had killed. As soon as discovered by the parent birds, they were forced to beat a retreat, but they invariably returned when the opportunity offered, until the dead birds were nearly devoured.

Another and much rarer species of mouse, the pretty kangaroo or jumping-mouse, merits our attention; and I only regret my opportunities for observing it have been so few and unsatisfactory. This little mammal—not a true mouse, by-the-way—is not unlike the preceding in its habits, though he is easily distinguished by the wonderful leaps he takes when pursued. From the few observations I have been able to make, this jactatorial locomotion is not its ordinary method of traveling. Although its fore-limbs are so short, it scrambles over the ground with as much ease and rapidity as other mice. If pursued, however, and extra speed is required, then its whole manner is changed, and it seems quite like another animal. It takes enormous leaps, one after another, with great rapidity, and, when the conditions are favorable, it distances most of its pursuers. Remarkable as are the leaps made by this mouse, I have never seen them clear "five or six feet at every spring," as described by Godman. Without the means of determining this point, I should judge that one half that distance was more nearly correct. Here, perhaps, it is legitimate to ask the question, Has their jumping power at all decreased? It is not unreasonable to suppose that such should be the case, if the habit of jumping arose from the necessity of eluding certain enemies which do not now exist in as great numbers as formerly. Certainly, at present, in this neighborhood, these mice have no more enemies than the white-footed or the meadow mice, nor are they apparently any more secure from the attacks of these enemies, because they can jump a little faster than the others can run.

Godman remarks of this animal: "At the commencement of cool weather, or about the time the frost sets in, the jumping-mice go into their winter-quarters, where they remain in a torpid state until the last of May or 1st of June. They are dug up sometimes during winter from a depth of twenty inches, being curiously disposed in a ball of clay about an inch thick, and so completely coiled into a globular form as to conceal the figure of the animal entirely." My own observations have not been in accordance with the above, so far as the "ball of clay" is concerned. Such as I have found had well-built nests of fine grass and bits of hornets' nests, placed in a roomy underground chamber, usually so situated as not to be exposed to excessive dampness.

Its hibernation is certainly much more profound than that of the white-footed mouse, which voluntarily rouses from its winter slumbers; furthermore, the jumping-mouse does not hoard grain, as does the latter.

CHAPTER X.

MUSK-RATS AND SQUIRRELS AS WEATHER-PROPHETS.

The musk-rat is too well known to require any particular account of its daily habits; although there is always something to be learned about any and all animals.

Having successfully withstood the encroachments of man, and indeed having often been benefited by its ability to utilize the constructions of man, such as the banks of canals and ditches, the musk-rat is now about as abundant as ever, and thrives in spite of constant persecution, not alone in retired situations, but often within the very limits of our cities.

As to their numbers now, when compared with a century ago, there is probably some slight decrease, but it is not much. Kalm (1749) says, "The *Swedes* asserted that they could never observe a diminution in their number, but believed that they were as numerous at present as formerly." They were hunted then quite as persistently as at present; and possibly even more so, as their fur was more in demand.

But well and accurately known as the musk-rat is to many, there is still a very prevalent misconception in the minds of people generally with reference to certain of its habits, and particularly to those referring to its winter life. In calling attention, then, to its winter haunts and habits, there will occur a fitting opportunity of correcting certain distorted facts and curious fancies, not only about this animal, but also in relation to the great majority of our mammals.

Besides the extensive burrows in which, during the greater part of the year, the musk-rats live, they often erect, in autumn, quite elaborate structures, in swampy ground, or occasionally in shallow and quiet waters, when they can find safe anchorage, as for instance to a stump. These winter-houses, as they are usually called, are conical in shape, and generally about three feet in diameter, at the base, and two or three feet in height. The materials used in their construction are long, coarse grass, bulrushes, twigs, and some of the larger limbs of shrubs. I have never discovered any evidence that, beaver-like, they gnaw off saplings of water-birch for the purpose of using them in house-building, but that they do so, at times, has been asserted by many. The materials gathered are closely cemented with stiff, clayey mud, which the musk-rats procure from the beds of streams, often burrowing beneath the sandy superstratum to secure it of the proper consistency. When sun-dried, these structures are very strong and will bear the weight of a full-grown man. The walls are generally about six inches in thickness, and are very difficult to pull to pieces. The interior consists of a single circular chamber, with a floor that is ingeniously supported on coarse sticks driven into the mud, after the manner of piles, and among them are laid horizontally many others, thus making a strong but open foundation, upon which are placed small twigs, stiff mud, and over all a layer of soft grasses. This interior is arranged after the dome is completed. In the center of the floor is an opening, leading by several, often six or eight, diverging paths, below the water-level, and extending to the nearest higher or comparatively drier ground. Through these the musk-rats make their escape, if the home be disturbed; and it is only by first discovering these paths and blocking them, or by closing the one exit at the base of the house from which the paths start, that it becomes possible to secure all the occupants of one of these winter nests or homes. While the exterior of these structures is quite irregular and apparently rudely or carelessly put together, it is evident that this exterior is designedly arranged in this manner to make the home appear like a stranded bunch of trash, transported thither during some sudden rise and overflow of the stream, or some filling up of the swamp, as the case may be. The interior, however, of these structures is usually neatly furnished and smoothed, and with its lining of soft materials, the entire structure bears no little resemblance to an enormous bird's nest turned upside down.

Even more than in the case of birds' nests, however, there is a great deal of variation among these structures, and the above description of a typical nest is taken from my notes of two such structures which were carefully examined in the winter of 1880–'81. I have in this description made use of the best features of the two nests or homes, and given a fair idea of what the structure is, when every condition is such as the musk-rat desires. Like birds, however, they have usually some objectionable feature to contend with, and hence they never erect precisely such a home as they are capable of constructing.

Now these nests are not built every year, by any means. In the same locality, near my home, where a colony of musk-rats have good quarters and a comparatively easy time, these animals one year content themselves simply with their burrows in the higher ground that bounds the wet or "mucky" meadow; and the next year they erect one or more of these dome-shaped houses. I had long noticed this irregularity, and having mentioned it at various times to trappers and the "old folks" of the neighborhood, was in every instance assured that, when no such houses were built in the fall, the winter would be very "open" or mild, and *vice versa*. In other words, the power of foretelling the character of the coming winter was ascribed to the musk-rat by these trappers and old folks generally, who are popularly supposed to have gained much accurate knowledge from long observation. "Nature," indeed, "is an admirable school-mistress," but careless scholars do not do her justice. I was the more surprised at this, too, because I have found that these same people can generally give us more accurate details of the habits of our animals than are found in the books.

Having my doubts as to the truth of this, as well as other "common impressions," I have for many years tested the matter, and noted down in what years houses were built in the same localities, and when none were erected. The result was about as I expected. In the majority of instances it proved to be precisely the reverse of what I had been told. As an example of this, take the two winters, 1879–'80 and 1880–'81. The former was very mild and spring-like, and numerous large houses were built; during the succeeding autumn, in the same locality, none were erected; and the character of the winter was precisely the opposite of the preceding one. Now, the musk-rats were here all winter, just the same, but they lived in their subterranean homes. The records of the past twenty years, in fact, clearly show that the "common impression" should be reversed, if it be true that there is a ghost of a connection between the custom of erecting these conical houses in autumn and the character of the coming winter.

Why these winter-dwellings are not always erected, is not easy to determine; nor do plausible explanations suggest themselves. That it is in some way connected with their food-supply in winter is probable, and there may be some connection between the habits and the general condition of the springs and the abundance of surface water. I have thought that when the springs were "up" and the swamps full, in autumn, these houses were more likely to be built, and *vice versa;* but I have noticed several exceptions, and do not feel assured that I am right in my surmise. At all events, there is no reasonable ground whatever upon which to base the assumption that musk-rats can foretell meteorological changes, beyond such as may occur within twenty-four or thirty-six hours. Far be it from me to deprive any of our mammals of all due credit! On the contrary, my whole sympathy is with that view of their origin and of man's that gives the same powers, but in different degrees, to them and myself; but there is as yet nothing discovered in the life of a musk-rat that even vaguely hints at the possibility of a prophetic power beyond the capabilities of any ordinary weather-witch.

Let us now consider, in this connection, the habit of many mammals of storing away quantities of food for winter use. As the musk-rat does not hibernate, and is not affected in its movements by the severity of winter weather, it requires no such magazines of supplies, and consequently has none. The winter-houses it erects have a bearing, I doubt not, upon the food-supply, which is probably more accessible from these structures than from their ordinary burrows. On the other hand, many mammals have but one class of retreat, summer and winter, and these gather in autumn, for winter use, enormous quantities of nuts and seeds, which are their sole dependence. Now, the same question arises here as in the case of the musk-rat: Have these "harvesting" animals any means or power of foretelling the character of a coming winter; and do they differ in the habit of storing up food, to an extent commensurate with the great variability of the winters? For if a winter is steadily cold and prolonged, as was that of 1880–'81, the time passed in slumber will be equally extended, and a much less quantity of food will be consumed. If, however, the weather is as mild as the winter of 1879–'80, then these animals will be quite active much of the time, and of course consume a larger amount of food. This was the case in the winter last mentioned with both the gray squirrels and the chipmunks, and I venture to state that there was no more food stored the preceding autumn than in the fall of 1880, when winter set in about November 25th. It is also probable that no food whatever was consumed during the three winter months that followed, yet I am assured that the amount of food stored by these animals does vary, and that when much is stored, the winter will be severe, and *vice versa.* This shows not only great ignorance of the habits of common animals, but the illogical position of those that so confidently make the assertion is evident from the fact that if the weather is mild and the animals awake, then the greater supply of food is, of course, required; for it must be remembered that the amount of foraging in mild weather is so little that it does not become an important factor in this question.

The habit, *per se*, of storing food for winter use is beyond dispute, and it now behooves us to consider the variability of this practice and to seek the explanation of the fact that more food is stored some winters than others. It can scarcely be ascertained when and how the habit of storing food for winter use was acquired. Doubtless it dates back as far as the glacial period, but this does not concern us. What of the habit as it exists to-day?

First, let us glance at the subject of our climate as it is, and as it was some two centuries ago. Kalm says that, "desirous of hearing from the old *Swedes*, who have lived longest in this country, and have been inhabitants of this place" (Raccoon, in Swedesboro, Southern New Jersey) "during the whole time of the change mentioned, whether the present state of the weather was in some particulars remarkably different from that which they felt in their younger years, the following is an account which they all unanimously gave me in answer to this question :

"The winter came sooner formerly than it does now (1749). Mr. Isaac Norris, a wealthy merchant, . . . confirmed this by a particular account. His father, one of the first *English* merchants in this country, observed that in his younger years (about 1690), the river *Delaware* was commonly covered with ice about the middle of *November*, old style, so that the merchants were obliged to bring down their ships in great haste, before that time, for fear of their being obliged to lie by all winter. On the contrary, this river seldom freezes over at present before the middle of *December*, old style.

"It snowed much more in winter, formerly, than it now does (1749); but the weather in general was likewise more constant and uniform, and when the cold set in it continued to the end of *February* or till *March*, old style, when it commonly began to grow warm. At present it is warm, even the very next day after a severe cold, and sometimes the weather changes several times a day.

"Most of the old people here were of opinion that spring came much later at present than formerly, and that it was now much colder in the latter end of *February*, and the whole month of *March*, than when they were young. Formerly the fields were as green and the air as warm toward the end of *February*, as it is now in *March*, or in the beginning of *April*."

It can scarcely be said that any change has taken place during the one hundred and thirty years since the above was written, except that the snow-fall has much decreased. This has not arisen from a warmer temperature, and a consequent change to rain-fall instead of snow, but is an absolute decrease in precipitation. There is certainly considerable evidence to show that this corner of the world is slowly drying up, even if the globe, as a whole, is not.

Let us now turn to what the same writer says of the gray squirrels. He writes: "The squirrels gather great stores for winter, which they lay up in holes dug by them for that purpose; they likewise carry a great quantity of them into their nests.

"As soon as winter comes, the snow and cold confine them to their holes for several days, especially when the weather is very rough. During this time they consume the little store which they have brought to their nests; as soon, therefore, as the weather grows milder, they creep out, and dig out part of the store which they have laid up in the ground; of this they eat some on the spot and carry the rest into their nests on the trees. We frequently observed that in winter, at the eve of a great frost, when there had been some temperate weather, the squirrels, a day or two before the frost, ran about the woods in greater numbers than common, partly in order to eat their fill, and partly to store their nests with a new provision for the ensuing great cold, during which they did not venture to come out, but lay snug in their nests; therefore, seeing them run in the woods in greater numbers than ordinary, was a safe prognostic of an ensuing cold."

Here we have plainly attributed to the gray squirrel a weather-foretelling power, which certainly is not exhibited by these animals at present; and, more strangely, Kalm does not suppose them ever to become torpid in winter, which they now unquestionably do. Finally, the underground storehouses of gray squirrels are but seldom made in this neighborhood, though enormous quantities of nuts are stored in the tree in which their nest is, or in one very near it. This, at least, is the rule within the range of my own observations. In the extracts from Kalm's volumes, we have intimations, at least, of a slight change in the habit of storing food, and apparently a great change in the fact that these animals now hibernate to a variable extent, though formerly they do not appear ever to have become torpid. If this be true of squirrels one hundred and more years ago, why should the habit of hibernating have been acquired, when the climate was gradually becoming more mild, as it surely is? Has hibernation taken the place of storing food? Has less food, of late years, been stored, and forced semi-starvation brought about the hibernating habit? From my own observations, made during the past twenty years, I do not find that the bulk of nuts, seeds, and corn stored by harvesting animals varies to any important extent—certainly not, so far as gray squirrels and chipmunks are concerned. I found just as many storehouses of the chipmunks in the open winter of 1879–'80 as in the "Arctic" one of 1880–'81; and yet the amount consumed the former year was probably one half of that gathered; while in the latter the amount consumed was almost nothing. At the time of this writing (April, 1881), the magazines of the gray squirrels are well stored, simply because these supposed non-hibernating animals did not eat a nut apiece from early in December until late in February. If ever there were two consecutive winters which tested the question of the variation in the amount of food gathered, and its bearing upon the coming season, it was the two winters I have mentioned; and I could find no evidence, in anything that the squirrels actually did, that had any bearing whatever on the character of the season, or hinted at the possession of a power to foretell the weather. Certainly the experience of these two winters contradicted the general impression as to any essential variation in the "harvesting customs" of these animals, in accordance with the "openness" or severity of the season.

We are now brought to the consideration of another phase of this subject, which is of much interest. It is well known that the yield of nuts of all kinds varies to a considerable extent, and we can readily imagine a case where, there being an abundance of gray squirrels and a "short crop" of nuts, the supply stored away for winter was less than usual; or if, from any untoward accident, a family of squirrels were deprived of a large portion of the supply they had gathered—what, under these circumstances, will be the result? Of course, if the weather is very mild, the squirrels will resist the tendency to keep "in-doors," and will sally forth in search of stray acorns; or if, the ground being covered with snow, these are inaccessible, they will feed on leaf-buds of the trees; but if the weather is too severe for out-of-door work, then can they voluntarily pass into a lethargic state, and thus eke out their small store? I am disposed, both from observation and experiments, to believe that they can. Unlike some mammals, these gray squirrels can withstand a great degree of cold, and their sleep, when deprived of food in cold weather, is to all appearances true hibernation, and often extends over a period of three weeks. Rousing from their nap, they will eat greedily if food is accessible; but if not, the sleep will be resumed. This, in winter; but in summer the same experiment results inevitably in starvation.

This evidence of optional hibernation is, I consider, far more wonderful than any power to foretell the character of a coming season, which, in the case of the musk-rat, or of the squirrel—judging the one by the houses it erects, and the other by the food it stores away—is a faculty that I do not believe they possess.

CHAPTER XI.

DOES THE OPOSSUM PLAY "'POSSUM"?

Among the few mammals that have successfully withstood the encroachments of man upon their haunts, no one is more interesting to me, in its habits generally, than the well-known opossum. The earliest notice I find of these animals is by Gabriel Thomas, who, in his sketch of Pennsylvania and West New Jersey, published in 1698, refers to "that strange Creature, the Possum, she having a Belly to swallow her Young ones, by which means she preserveth them from danger, when anything comes to disturb them." On the other hand, Kalm appears to have overlooked them, making no further reference to the animal than to remark that "the opossum, like the otter, can be tamed so as to follow people like a dog"—a statement that scarcely holds good of the opossums about here to-day!

These animals, it has always appeared to me, are devoid of cunning, even in choosing their nesting and resting places, and it has always been a mystery to me how they have managed for so many years to escape extermination. Yet, stupid as they unquestionably are, they are still abundant, even in the immediate vicinity of large towns. Being of a low type of mammals, and characteristic of an early geological epoch, are we to infer that their want of cunning arises from this fact? If so, it seems strange that, through the inherited experiences of an immensely extended ancestry, they have not acquired some small degree of intelligence; but this they do not appear to have done. They pass their days in a happy-go-lucky manner, and, if they reach old age, it is through good luck more than good management.

The habits of the opossum may be thus summed up: Choosing a hollow tree, one in which a whole family can live, or a hole in a hill-side, which they do not alter and seldom dig for themselves, they sleep much of their time; and when they occasionally wander about for food it is generally at night, especially if it be moonlight, though sometimes they go in broad daylight. They appear to have no marked predilection for any one kind of food, and exercise no ingenuity in procuring it, being as apt to seize a chicken if it comes in the way, during the day, as to stealthily attack a hen-roost after sundown. One peculiarity, indeed, I have twice witnessed. This was the tearing apart of a very soft, decayed log, and the capture of a nest of large black ants. In a bungling way they imitated the ant-eaters, and licked up with the tongue the ants and their larvæ, but they seemed to swallow more rotten wood than insects. If so, the wood, I imagine, would make a very unpalatable if not an indigestible meal.

Unlike our other mammals, the opossums have no special fear of man, and make no effort to avoid him. During autumn, especially, they wander about by day in the most unconcerned manner. Frequently I have met them in narrow wood-paths, with a safe cover on either side, but, instead of beating a retreat, they have stopped to see if I would get out of their way. Of dogs they have some fear, however, and will shuffle off if they see or hear one; but even then they frequently only climb a short distance up a tree, and remain in full view.

Unlike every other mammal in New Jersey, the opossum appears to be nearly or quite voiceless. I do not say that they have no squeak or louder cries, but time and again I have endeavored to force them to utter some sound, but always in vain. Even in early spring, when several males were together and disputing, by actions, over the unconcerned females near by, they appeared to be quite dumb. Many times my opportunities have been most favorable for detecting any sound that they might make, but I have heard nothing. When captured there may sometimes be noticed a faint hissing sound, but I do not think it is voluntarily produced.

Reference has already been made to the peculiarity in the anatomical structure of this animal which distinguishes it from all other North American mammals. Earnest as have been the efforts of many observers to learn the details of the breeding-habits of the opossum, there yet remain some points of interest to be determined.

In a communication to the Essex Institute of Salem, Massachusetts (Vol. III, p. 288), Mr. Shute gives the following as his own observations, made at Beaufort, North Carolina:

"The date of the birth was March 16, 1863. During the delivery of the young the parent lay on the right side, with the body curved in such a manner as to bring the sexual organs opposite that of the pouch; the mouth of the pouch was open and drawn down by contraction of the muscles so as to receive the young when delivered. The young were seven in number. The time occupied in delivery was about four hours. The parent remained in the same position about thirty-six hours, and refused all sustenance.

"Immediately after the transfer of the young to the pouch, I removed one, by detaching it from the teat, in order to ascertain if the movement of the fœtus was instinctive. I found that it was at least partly voluntary, as it made an effort to regain its place in the pouch, and the same movement was made by the parent, as at first, to receive it. I did not notice any use of the limbs or lips of the parent during the transfer of the young."

A few words in conclusion, concerning the supposed peculiarity of the opossum in feigning death when captured.

As the result of the systematic and rational study of animals has been to realize that animal and vegetable life is but an uninterrupted series of forms, from the lowest to the highest and most complex organisms, there has been a tendency to see, in the phenomena exhibited by lower organisms, merely a modified condition of that which man, the highest organism, habitually exhibits under like circumstances. While admitting that man has no power, or gift, so called, not directly derived from the lower forms of animal life, may it not be that, in observing the habits of such lower forms as come under our notice, we are sometimes misled by making personal comparisons? and what a man might do, or probably or undoubtedly would do, under given circumstances, is not what the observed lower form of animal *is doing*, in spite of appearances to the contrary. I have been led to this conclusion by the patient and cautious study of the habits of the opossum as it is now found in the immediate vicinity of thickly-settled districts, where but little cover is afforded, and where its limited ingenuity is wholly required to make good use of that which remains.

While the habits of all the mammals still found in settled and cultivated districts, unless it be the mice and moles, are doubtless more or less modified by the extra exertion required of them in contending against the almost constant presence of their two greatest enemies, man and the dog, thus increasing their ingenuity, it can never be determined how far the raccoons, otters, and minks of to-day are in advance, either in intelligence or cunning, of those of some few centuries ago. I presume that the struggle for existence being more desperate, they are more cunning—we know they are more wary—and that they have had transmitted to them the experience of hundreds of generations. This is readily seen in the case of many birds, notably the common crow, and why not, therefore, with a higher organism? In the case of the stupid opossum, this question is scarcely applicable, as that animal is a link connecting the present with the past, and therefore not to be judged under the laws governing the present. Further, the low intelligence of the opossum seems rather to favor the view I shall express concerning the peculiar habit that has rendered the animal quite famous.

Whenever the opossum is captured, it is popularly supposed to feign death, or to "play 'possum," as it is usually called. Now, does this really occur? Does the opossum ever deliberately make the effort to deceive its captors by assuming such a position, and suppressing its breath to such an extent as to appear dead? If such be the case, it is well to look beyond the mere fact of thus feigning death, and see what such an act, if voluntary, really indicates:

1. The object being to render itself useless or unattractive to its captors, the opossum must be credited with supposing that, if it can appear to be dead, it will be useless to its captors. Now, what is there in opossum-life that could give rise to such an impression? Could the experience of past generations, exposed as they were to

the enemies characteristic of the different environment of that time, do so? Here it may be added that the results of this supposed feigning are never such as to warrant the animal in so doing.

2. The assertion that the opossum feigns death necessarily assumes that the animal in question realizes what death is. While it may be admitted that, being a semi-carnivorous mammal, it must know what the death of its prey means, does any animal realize that that is its own inevitable fate? When badly wounded, or worn out with age, an animal "crawls away to die," but is it not as probable that, in seeking a retired spot, it does so with hopes of recovery, rather than with a feeling of resignation at its approaching dissolution? I must confess, however, that the well-known fact that scorpions can be induced to commit suicide, appears to effectually set aside my belief; unless, indeed, this act on the part of scorpions may have some other than a suicidal explanation. Still, I am disposed to believe that the pleasant knowledge of approaching death and its certainty is confined to man. If so, then in fancying that we see death feigned on the part of the opossum, we ascribe to it a process of reasoning which is fallacious, and would, if persisted in, have resulted in the extermination of the species; while as a fact we find that it has, on the contrary, been able to withstand the encroachments of farming operations, and the destruction of timber about its haunts, which have driven off some of the smaller and all of the larger mammals. If this is the habit of the opossum, it must necessarily have originated long prior to the advent of man upon the earth, and been acquired as a safeguard against the attacks of enemies not now existing, which would not molest it if they supposed it to be dead. At present, this supposed habit is not a protection against the attacks

of dogs, its only enemy here except man, and yet after an ineffectual resistance the same act is gone through with when attacked by dogs as when captured by man. It is a habit that militates against its safety, and could never have been acquired in its present environment. Speed, if exercised, would in many cases insure safety, and the opossum can run when it chooses to make the effort. That the supposed habit of feigning death was acquired as a safeguard against pursuit by man solely, is absurd, inasmuch as in this case it does not conduce to the safety of the animal; and to assert that any habit was acquired solely as a means of guarding against the persecutions of man, is to ascribe a very high grade of intelligence to the most stupid living mammal. Whatever the origin of the habit, if such it is, it can not be logically regarded as voluntary. The brain of the opossum is too primitive to have evolved this degree of cunning, forethought, and contrivance.

In order to test this supposed habit, I have sought out their hiding-places, in numberless instances, and endeavored to make them "show off" in this manner. In one case, a large male opossum was captured in an ordinary box-trap, set for rabbits. On lifting the lid of the trap, the animal was found to be curled up into a form as nearly globular as it was possible to assume. Being disturbed, it slowly raised its head, opened its mouth wide, but did not offer to bite, and in this position it quietly awaited coming events. After some five minutes of mutual staring, the opossum closed its mouth and slowly restored its head to a more easy position, and even closed one eye, as though the other was all that was necessary to note what might occur. On being roughly handled and given several pushes with a stick, it again opened wide its mouth and protested against disturbance by a low, hissing sound, but did not uncoil its body.

If the animal, at this time, realized that it was a prisoner, it certainly did not fear death, for it made no effort to escape, which the fear of death would cause it to do, since it was in no way disabled. After waiting an hour, and seeing no sign of feigning unconsciousness, but, instead of it, a most provoking indifference, I walked off some distance to a point where I could see the trap, but was myself hidden from the opossum. Fully ten minutes elapsed before I saw any movement on the part of the animal, and then it was a very gradual uncoiling of the body, a protracted yawn, a stretching of the limbs, and then standing up, he looked about and very deliberately walked off. I ran toward him, when he quickened his pace, but was soon overtaken. On seizing him by the tail, he crouched down, partially coiled his body, and spread his jaws to the utmost. When I threatened violent blows about his head (although careful not to strike him), the animal's head slowly sank down, and the eyes closed, but this was not a feigned act. The breathing was affected but not suppressed, the surface temperature of the body was lowered, I judged, and it was, as I believe, a faint, and not a feint; a temporary paralysis of the whole body through fear, and for the time being absolute unconsciousness. Furthermore, as in fainting, the application of cold water had the effect of restoring the animal to consciousness. I have made scores of experiments of this kind, in some instances actually striking them, when the *fainting through fear* was more sudden; and in no experiment have I seen anything to suggest intentional feigning of death.

The late Dr. Lincecum, in a sketch of the habits of the opossum, as observed by him in the Southern States

("American Naturalist," Vol. VI, p. 555), speaks of their being attacked by turkey-buzzards, and "going into spasms," during which the buzzards pick out their eyes and otherwise wound them. This being the ordinary result of a "make-believe," would even as foolish a creature as the opossum long continue it? Again, Dr. Lincecum speaks of "kicking over" an opossum, which "immediately went into a spasm." This is a very different matter from feigning unconsciousness.

As to the position usually assumed when the opossum is supposed to be feigning death, it is that which the animal assumes when sleeping; and, further, is the one best calculated to prevent injury from blows, as the head and breast are partly protected.

As this animal is superlatively lazy and positively timid, and by no means intelligent, when compared with the mink or raccoon, I believe this supposed habit of feigning death is attributable to fear and not cunning; and certainly it is a merciful provision that thus destroys, without pain, all sensation in animals about to be torn to pieces.

CHAPTER XII.

OUR BIRDS IN GENERAL.

The Duke of Argyll lately illustrated most forcibly the truth of the saying that "a little learning is a dangerous thing," when he wrote disparagingly of the vocal powers of American birds. Had he been with me one spring-like April morning of the past year and heard the "burst of song," lasting from sunrise until high noon, to which I listened, his want of appreciation of our birds would have been changed, I doubt not, to enthusiastic admiration.

For several days the birds had been arriving, one or more kinds at a time, but it was not until the 29th of the month that the summer birds had arrived in full force. The brown and the wood thrush, the cat-bird, the bobolink, and the two species of oriole, the three wrens, and a host of other merry warblers were here on that day, each in full song, and congregating in their several haunts they united in giving a ringing welcome to the coming summer. What with the added voices of our winter birds, the lark, the sparrows, and the gay cardinal, there was nothing wanting in the songs they sang—no check to the melody of their choral greeting. Amid the bright surroundings of the young leaves, through which the trembling sunbeams danced in glee, these feathered choristers charmed alike the eye and ear, and I listened for hours to the glad refrain, which even yet lingers in my ears.

But we have other birds besides those that sing, and no lack of them. To realize how numerous they are, and how varied in every bird feature, it is only necessary to take a quiet country ramble—not along the dusty highways, for there you will only see the alien sparrows —but in the woods and through the swamps, over the meadows and along the river-banks. Do this, and the wealth of bird-life here will be duly appreciated, and not otherwise. The truth is, our hawks are as brave and our crows as saucy as any that can be found; our quails, too, are as gamy, our herons as stately, our ducks as shy, and our divers as impudent, as those of other continents; and, best of all, there is an abundance of them.

It is not my purpose, however, to maintain the superior excellences of our many song-birds, or uphold the merits of those whose virtues are other than vocal. Those who know our birds best, know well their capabilities; and it may be thought a mere repetition of what has been often said before, to mention again either their songs or their general habits. Nevertheless, I am led to do so for the reason that I do not believe that the whole history of any bird will ever be known; and because I am convinced that the nearest approach to it will be in the sum of the results obtained by different observers, living in widely separated localities. The things that I have seen in Central New Jersey are not the same that would have appeared to an observer in the mountains of Pennsylvania, in New England, or in the Western States, for it is with the habits of birds, not their anatomical peculiarities, that I am concerned, and these are decided by the bird's environment. As this is widely different in different portions of the range of any species, it necessarily follows that there must result certain peculiarities of habit incident to the locality that are of interest to the philosophical naturalist.

In a region like Central New Jersey, which seems to be a neutral ground between the ranges of Northern and Southern species, it is scarcely practicable to determine precisely the avi-fauna. Every year adds additional instances of the occurrence of some rare straggler; and, in accordance with the character of the winter especially, is there an abundance or otherwise of certain species that make a brief stay during that season. Again, it is scarcely practicable for an observer, however enthusiastic, to be out-of-doors the entire day, and, I may add, evening; and yet, unless thus constantly on the watch, the coming and going of certain species will escape his notice. A list of birds characteristic of a given locality is of value as a catalogue of a very limited area, and does not hold good over any considerable number of square miles, for the variation in the surface geology or physical geography of the neighborhood affects in a marked degree the habits of some species, and decides the presence or absence of others during a part or the whole of the year. As an instance, Gentry, in his "Life Histories of Birds," refers to our common meadow-lark as migratory about Germantown (Philadelphia), Pennsylvania, while in this neighborhood it is a winter resident; and the same might be said of several other species. Yet the field of Mr. Gentry's observations and my own are but thirty miles apart as the crow flies, though geologically they are as different as well can be.

In conclusion, it may be added that in the uplands and meadows, and along the river-banks, I have noted one hundred and seventy-two species of birds. Of these, many are migratory, while others visit us but rarely. Of those that remain throughout the year there are but few, though at no season are we without a sufficient variety to make it as pleasant as it is profitable to indulge in out-of-door studies in ornithology. Even in the gloomiest days of winter there will always be a stray song-sparrow, nuthatch, or tit, a brave cardinal, a lark, or at least a crow, jay, or woodpecker, to enliven the woods and fields, and no bird can be long watched, as it hovers about its chosen haunts, without giving us some further insight into the mysteries of bird-life.

CHAPTER XIII.

THE MIGRATION OF INLAND BIRDS.

As understood by me, the migration of a bird is simply the desertion of a given locality for a certain and always the same portion of each year. As an example, the common house-wren is migratory, in that it remains in New Jersey only from late in April until late in September, having left its southern home for six months.

Before endeavoring to determine the causes of this movement on the part of some birds, we must first note the various features characterizing the movement itself—for it may safely be asserted that no two birds migrate in the same manner, although the similarity is marked among the various species of the same family. The most notable feature in migration is the apparent uniformity in the time of its occurrence; that is, of the dates of the arrivals in spring and of the departures in autumn. Is this arrival in spring as regular as claimed by some and supposed by most people? To the casual observer, and indeed to many who have for years noted the first appearances of our various birds, the arrival seems to be quite regular; and, curiously enough, we find many such observers insisting that, however late a bird may be, any one season, he is never earlier than a given date. Thus we have been frequently told that the wrens are never seen before May 1st, and that usually upon that day they are here in full force. Now, let any one watch day and night for the first birds of the season; let him wander all day in or about tangled thickets and sheltered, sunny hill-sides; let him, with sleepless eye, scrutinize every haunt of the birds, and with vigilant ear listen to every faint chirp and far-off twitter, and follow up every undetermined bird-note; let him do this, year after year, from April 1st to the 30th, and he will find his note-books teeming with records of early birds, that will come and go all unsuspected by the mid-day observer, who often will insist upon the absence altogether of many a summer songster, which, skulking about, withholds its joyous songs until the woods have welcomed the full company of its kind, that of old have made merry in its shady nooks. The fact is, there is more to be learned about birds in one hour of the early morning than in six weeks of midday sunshine.

The amount of variation in the dates of arrival of all of our spring birds is really considerable, and in the whole list of migratory inland birds that annually visit New Jersey, either to remain throughout the summer or on their way to more northern localities, there is not one that can be considered regular in the time of reaching here, by from twenty to thirty days.

The amount of variation in the dates of arrival, year after year, of the same species—say of the brown thrush, cat-bird, or yellow-breasted chat—is less, however, than in the time of arrival of allied species, as, for instance, of the various species of thrushes which reach us very irregularly. The robin is a resident species; the wood-thrush appears from April 15th to May 10th; the tawny thrush sometimes later by two weeks, and sometimes absent altogether; the olive-backed thrush passes by irregularly as to both time and seasons, and so, too, does the hermit-thrush, which, however, occasionally remains throughout the summer. The brown thrush, or "thrasher," comes to us by twos and threes as early as April 20th, and not until after the 1st of May can they be considered as present in full force. The mocking-bird is very irregular, both as to years and dates, and the cat-bird, never missing a year, wants the early May foliage developed in which to skulk. Often in "single blessedness" he comes to his last year's haunts, and is wonderfully ingenious in his efforts to conceal himself in the leafless thickets of early April, keeping ever close to the ground, and never venturing upon the slightest attempt at a song.

The many notes I have made with reference to the warblers also indicate a great degree of irregularity and uncertainty in their migratory movements. This applies to these birds not only as a family, but to all of the various species separately, of which a score or more generally pass through the State. During certain seasons I have noticed a marked preponderance of some one or two warblers which in the following seasons were much less common than many other kinds of birds. Thus, in 1860, 1864, 1867, and 1872 the common redstarts were very abundant, not only about their natural haunts, but within the city limits, and scores of them could be seen climbing over and flitting through the branches of the shade-trees of the less-frequented streets. Since 1872, except in 1882, these birds have not been so numerous; indeed, they have been far less so than many other warblers, such as the yellow-rumped, the black-throated blue, and the yellow summer warbler.

Unlike the thrushes, the warblers seem to be largely controlled by meteorological influences; and sudden changes of the weather, which, unlike some birds, they seem unable to foretell, greatly influence their movements, and certainly delay their northward progress; and yet, while

I have frequently known them to be caught in a "north-easter," they are not otherwise affected by it, so far as I could determine, other than by the delay before mentioned. Even a sudden change from warm, summer-like weather to decided cold, did not apparently destroy any of them or check their lively movements among the trees.

Let us glance at the well-known swallows. For five months of every year we have with us, in greater or less abundance, six species of swallow and one "swift," the common chimney-swallow. Of these, one, the rough-winged swallow, is comparatively rare; the white-bellied are not particularly abundant, except during certain seasons; the cliff-swallow is erratic, now here, about the barns and stables of a circumscribed neighborhood for several years, and then wholly failing to appear in their former haunts. Not so, however, with the barn-swallow; with a variation in date of arrival of about ten days, there comes to us in May our full complement of these beautiful birds. They have decreased in numbers during the past fifty years, so observant old farmers have said, but probably not so much as they think. It is more probably the increase in the numbers of other species that makes the numbers of the barn-swallow seem fewer. The bank-swallow, earliest of all, is here literally by millions, and the purple martins, in moderate numbers, seldom fail to occupy the boxes placed for their accommodation; while, lastly, the chimney-swallow, I believe, has never failed to appear in about the same numbers year after year. I have fewer instances recorded of single swallows, seen at unusually early dates, than of birds of any other family. Some, indeed, arrive much earlier than others, as for instance the bank-swallow; but the difference in the date of its arrival, throughout any ten years, is certainly much less than it is with other birds, which with some is surprisingly regular, though not absolutely so, as is so often asserted.

Let us now glance at the peculiarities of this family of birds, and compare them with the thrushes and warblers. One marked difference is seen in their wonderful flight-power, the thrushes and warblers being weak in their powers of flight, positively as well as comparatively; and my observations bear me out in asserting, as a law of migration, that its regularity is in proportion to and solely dependent on the flight-powers of the species. With the entire list of inland birds of New Jersey we believe this to hold good.

I have already expressed my belief that many birds have the ability to foretell a coming storm. As this is not directly connected with the subject of migration, as I am now considering it, I will pass to another feature of this prophetic power, as it apparently is, in birds, and that is, their ability to judge of the general character of the coming season by a visit of a few days' duration early in spring. I have so frequently noticed that certain birds, common to a locality during the summer, occasionally fail to visit it, except in the case of one or two individuals, that come for a few days in April, that it has appeared as if these pioneer birds had satisfactory reasons for believing that there would be a scarcity of food, and so returned to meet their fellows, and, informing them of the fact, they all departed to "fresh fields and pastures new," just as a single crow, discovering danger, will turn a whole colony from their course as they are going to their roosting-place. This, be it understood, is a supposition, and may be wholly untrue; but how are we to interpret the meaning of any habit or particular movement of a bird, except by the human standard? An act on the part of a bird is intelligible to us only as we would interpret a corresponding act in man; and these acts in birds and men, producing allied results, indicate that close connection between all animal life which is so readily comprehended from an evolutionary stand-point. Now, as an instance of this "foretelling" power in birds, I noted, during the spring of 1874, the arrival of the first chewink or towhee bunting on the 27th of April. Busily it hopped among the dried leaves and tangled briers, enlivening the thicket with its constant song, just as a dozen of its kind had done throughout the preceding summer. In a few days it had disappeared, and not a chewink has been seen or heard for nearly six months. Late in October a few were noticed on their way south from the country north of us. This locality is one where these birds usually congregate, and I have often found a dozen nests within its limits. But, a few miles away, these birds were as abundant as usual. In two ways I can explain the absence of these birds: either those that were accustomed to occupy it went to a new locality, and the single bird that had preceded them, finding his companions did not come, left, rather than remain alone; or he left to announce that food would be scarce—for it must be remembered, as Darwin has remarked, "most animals and plants keep to their proper homes, and do not needlessly wander about, as is seen even with migratory birds, which almost always return to the same spot." At any rate, the summer of 1874, in this neighborhood, was the driest in the past fifty years, and it seemed as if the chewink knew what was coming. So, at least, I believe. During that summer I noted the nearly entire absence of several species which are common, as a rule, and a very marked decrease in the numbers of those that did appear; but, at the same time, my note-books mention the arrival of one or more individuals of every one of our migratory birds. Many, like the chewink, foresaw what was coming, and acted accordingly. It would be most interesting to determine if insect-life was less abundant than usual during that summer, but I can only note on this point, as suggestive of the fact that it was so, a marked freedom of the fruit-trees and fruit itself from the attacks of their insect enemies.

I must confess, however, that this explanation of the coincidence between the actual absence of the birds, and the occurrence of a remarkably rainless summer, does not lead me to believe that birds generally have a prophetic insight, or that they are habitually led thereby to prepare for the season, whatever it may prove to be. My statistics, covering many years, with especial reference to several of our smaller mammals, show that they do not possess such foretelling powers, and therefore it is the less probable that any bird should be thus gifted. When my remarks on migration were first written, I was disposed to attribute prophetic power to migrating birds. I let my notes stand as originally written, but must add, in this connection, that during the past eight years I have grown skeptical.

Another feature of the migration of our inland birds must here be briefly referred to; and that is, the failure of late years of certain species to come, as a rule, as far north as New Jersey; and also the habit, now fully acquired by others, of remaining throughout the year, when, but a comparatively short time ago, these same birds were truly migratory.

As an instance: the summer redbirds, twenty years ago, were regular visitors to Central New Jersey, arriving about the first of May and staying until October. They nested on trees, frequently in apple orchards, laying pretty, purple-blotched, green eggs. They preferred wooded hill-sides with a growth of underbrush, and having a southern exposure. In such situations they were numerous, and to one such locality, in particular, I can well remember the charm they added by the bright gleam of their plumage as they passed from tree to tree, uttering their peculiar but not melodious notes. For the past twenty years I have not seen half a dozen individuals, and no nests have been recorded since 1857. In far scantier numbers the scarlet tanager has taken their place, although this bird is not rare by any means, nor was it so when the preceding species was abundant.

It is much the same with the mocking-bird. Formerly as regular in its appearance, if not as abundant, as the cat-bird, it is now among our rarest summer visitants. An occasional pair, selecting some well-tangled thicket, will come late or early and build their nest, and then half a dozen years may elapse before we see them again. Yet fifty years ago these birds were common.

Gabriel Thomas, in his history of "Pensilvania and West New Jersey," published in 1698, in the list of birds of Pennsylvania to which his attention had been called, refers to this thrush as "that strange and remarkable fowl call'd (in these parts) the *Mocking-Bird*"; and again, in making a similar list of "West New Jersey" animals, he mentions "that uncommon and valuable Bird (being near the bigness of a Cuckoo) call'd the Mocking-Bird." From the prominence he gives it in the brief list of such large birds as geese, eagles, and pheasants, I presume that it was then a very abundant species. Fifty years later, Kalm found mocking-birds near Philadelphia, and remarks, "These birds stay all summer in the colonies, but retire in autumn to the South, and stay away all winter."

During the past half-century the numbers of these birds that visit New Jersey have undoubtedly steadily decreased. In such cases as have come under my own notice, however, the love of locality is very strong, and, if the nest is not disturbed, the pair will return year after year. It is probable that, in this case, withdrawal from so northern a locality is not voluntary, but is due to the almost certain persecution to which they are subjected. The remarkable vocal powers of the bird straightway publish the locality to every prowler, and the nest is soon sought for the valuable brood. In accordance with evolutionary doctrines, these birds should have learned in time to keep quiet, as their tongues are their worst enemies; but this probably is too great a sacrifice, and so they now remain away, or are so seldom met with as scarcely to be considered as an actual member of our avi-fauna. Once, however, in the past twenty years, there has occurred an unusual northward flight of these birds. In May, 1862, in several localities, they were noticed in considerable numbers, and attention was drawn to the fact in the local newspapers. It is not improbable that the war in Virginia, then in progress, had much to do with this; as it is evident that the constant cannonading and ceaseless blaze of camp-fires over much of the territory usually occupied by these birds would have the effect of driving them beyond the limits of these disturbances.

As instances of "spring arrivals" that have become resident species, I will first mention the well-known bluebird, which, whatever may be the state of the weather, is as lively and full of song from November to April as at any time during the summer; yet it is still considered as a migratory species, and formerly, I doubt not, was so, even in New Jersey. More interesting is the instance of the common yellow-rumped warbler, which, in scanty numbers, braves our winters, and from the tops of the loftier pines chirps merrily while the snow-flakes fill the air, though later in the winter it seeks shelter in protected nooks where the noonday sun has melted the snow and given us a breath of spring-like air. In several such spots, since February, 1863, when I shot the first winter specimen, I have not failed to find several individuals of this species during each of the winter months; and there seems to be a steady increase in the number of them that thus remain. The same remarks will apply, in part, to that beautiful but not well-known songster, Bewick's wren. They too, in scanty numbers, congregate in sheltered places, and even during the gloomiest of November days one may often hear the clear notes of this lively bird as it sits, braving a chilly westerly wind, perched on the topmost twig of some leafless tree.

A more marked instance than any, perhaps, is that of the great Carolina wren. In the "History of North American Birds," by Baird, Brewer, and Ridgway, it is stated that this wren "occasionally has been found as far north as Philadelphia," and that it is essentially a southern species. Although Audubon found it breeding in New Jersey fully fifty years ago, the probabilities are that, until recently, it was essentially a rare visitant to this locality. At the present time, however, this is far from being true, as it is really, in many localities, taking the place of the commoner house-wren. Neither is it "studious of concealment, and shy and retiring in its habits," but, on the contrary, it builds its nests in our out-buildings wherever a suitable locality offers, however much frequented the building may be. So tame, too, are they at such times, that it needs but little dexterity to capture them with the hand while they are sitting on the nest. They usually raise three broods, and are yearly becoming more abundant, and therefore a more prominent feature in our avi-fauna.

The interest centering in this species, however, is not the fact of their summer sojourn here, but that they have wholly relinquished the migratory habit. They are as abundant, as full of song, as familiar, and as superlatively restless and wren-like in January as in June, and in this they afford an instance of change of habit that is worthy of consideration. It is not the only example, however, of a wren braving the severity of our winters. We have the true winter wren, and, in scanty numbers, Bewick's wren. It has already been mentioned that the supposed regularity of the movements of the common house-wren does not now obtain. Indeed, during the past seven years, I have carefully noted the dates of arrival and departure of the house wren, and find that they are here both earlier in April and later in autumn than I had supposed. It would appear that they, too, are slowly becoming accustomed to our wintry spring days and early foretastes of winter, and that their tarrying with us is simply a question of food. In the case of the Carolina wren, may it not be said that the descendants of the wrens found in New Jersey, by Audubon, fifty years ago, have become acclimated, and so remain throughout the year; or do these birds, in scanty numbers, annually migrate from more southern localities, and leave a few of their progeny behind when the winter winds again drive them southward? It is immaterial which is the case, as it suffices to know that here, in Central New Jersey, the Carolina wren, a well-marked southern species, has of late years become an abundant resident species. With the change, too, has come a change in its habits, so far as this was necessary to enable it to seek a sufficient food-supply in winter. Just where it finds this food in midwinter, and of what it consists, I am not sure; but from the fact that it frequents our out-buildings, and is also often seen in the woods, especially among fallen timber, it is probable that hibernating insect-life and spiders afford it all needed nourishment.

I have now noted the more prominent features in the migratory habits of our inland birds as they come to us in May from the South, save the one fact, the bearing of which I can not determine, that, while a large proportion of the birds perform the journey by night, others travel wholly by day. At least this is the common impression, but it is difficult to demonstrate it. How little really do we know of the precise *modus operandi* of *migration!* All through April and May, if astir at the earliest dawn, when the resident birds are just starting their morning songs, we will occasionally hear the welcome notes of some summer bird for the first time. Has it been winging its way northward through the thick, black hours of night, guided by some unknown sense; and does it no sooner reach its old-time haunts than it checks its onward course, and from a familiar tree sings with grateful heart a loud thanksgiving glee?

If, during these same months, we wander about those quiet nooks and by-ways, where the first thrushes and warblers are likely to be seen, we shall find all the day long, and evening, too, that they are conspicuous by their absence. Not a chirp or twitter, save of the sparrows and tits that are with us all the year, and of the lingering snow-birds that seem to regret to leave our pleasant places. Far into the night we may remain, and only the startled chirp of some disturbed or dreaming bird, or the fret and scolding of little owls, will greet our ears. The silence of midnight may pass unbroken, and then, as the first gray streaks of light, in the hazy east, herald the on-coming day, suddenly a cheerful warble from some tall cedar, or tangled brier-patch, breaks the dead silence, and we mark the arrival of the first spring songster of its kind. Did it reach us at sunset, and, having rested a few hours, did it then announce its presence by its cheery song?

It may be that they come both by day and by night, but why at all by night, if indeed so they come, must ever be a great mystery in the strange habit of migration.

I let the above sentences stand unaltered, but the years since they were written have added to our knowledge of the migratory movements of our smaller, weak-flying inland birds. Not long since, many of these birds of several species were seen, by the aid of a telescope, moving southward, in large numbers, on a bright, moonlight night, flying at an estimated height of about two and one half miles. Straightway on reading this, I compared my dates of arrivals of all our birds, and then made comparison with the almanacs for those years. Twenty-three years of these notes should give us something worthy of acceptance, I think; and it was found that the nearer the full of the moon comes to the 1st of May, the earlier collectively arrives the full complement of our summer migrants. Of course, a storm may make a difference, and I think the prevalence of cold northerly winds does also; but still it may be accepted as a fact that very many of our birds take advantage of moonlight, and seeing where they are going, and knowing where they wish to go, they travel by night. This, of course, necessitates long journeys, and I am puzzled to know how those birds of apparently weak flight-power can cover such long distances. It can not be wholly due to their powers of endurance, but may be owing to some advantage taken, I know not how, of a strong upper current of air, that bears them along in the direction they desire to go.

It has been suggested that the vigor of the male birds and the distended ovaries of the females, at this time of the year, are doubtless coupled with a general vigor of the whole body; but it is questionable if this additional strength of itself is sufficient to enable these birds to fly for hundreds of miles without rest; and furthermore, if such is the case in spring, they have not this added strength in autumn, when also these long journeys are made.

Let us next study our birds during the autumn. A careful examination of the many notes, jotted down at frequent intervals, during the months of August, September, October, and November, with respect to the departure south of such of our birds as are summer residents, and of some that, having passed the summer in regions far to the north, are now likewise seeking their accustomed winter-quarters, indicates an apparent regularity in the southward movements of our birds, similar to what is seen in the spring, when they are on their way northward, and at the same time it shows an actual degree of irregularity in the dates of departure exceeding that of the dates of arrival.

An instance of this was brought to my notice one August morning in 1881. As a point of observation for noting the movements of certain birds frequenting the tops of our tallest trees, I sought a seat as near the top of a fine old chestnut-oak as I dared to go. While on my elevated perch, I was surprised to find that, now and then, a stray specimen of some unlooked-for bird would tarry a moment in the tree-tops, and then, resuming its high, southern flight, would pass quickly out of sight. Such birds were orioles, both the Baltimore and orchard; single rusty grakles; a Maryland yellow-throat, a ground loving species, still abundant in the thickets beneath me; a golden-crowned thrush; several black-throated buntings; and two humming-birds, male and female, still keeping company. The movements of all these birds impressed me with the belief that they were migrating birds, and not mere chance visitors. In most instances, they seemed to drop from above; they remained but a little while, never longer than ten minutes, and then took a distinctly upward flight until nearly out of sight, when they started down the river—that is, in a southerly direction. This movement, which was well marked in every case, I construed into a migratory one, and occurring as it did so early in the season as August 20th, it leads to the conclusion that the return or autumnal flight of our migratory birds commences very soon after incubation is over, and is not a sudden impulse that controls the movements of the entire number of any given species. Certain it is that the degree of irregularity in the return of the birds that pass northward in May is very great—much more so than is the onward movement in spring to their northern summer haunts. This does not apply to all species, of course, but to many; and it is precisely such exceptions—such semi-migrating or "irregular" species—that give evidence that the movement is slowly being relinquished, as being no longer absolutely necessary for their comfort and well-being.

There are two very common birds, belonging to widely different families, the habits of which, I think, bear directly upon this subject. One of these is the well-known yellow-breasted chat, the other the indigo-bird.

The chat is one of our latest spring arrivals, being very sensitive to changes of weather. If undisturbed, these birds occupy the same nesting-place year after year, building a new nest every season, more from necessity than choice, as the white-footed mouse generally so uses and abuses the old nest, during the autumn and winter, that it is usually demolished before the return of the birds the next spring. Now, I have noticed for years that the chats are full of song and very active until the young birds are able to leave the nest; and then it usually happens that within a week or ten days the whole family will leave the neighborhood.

After the middle of July and throughout August I miss them from localities where for ten weeks previously their curious medley of sweet and discordant notes was constantly heard during the live-long day, and often for half the night. This absence of these birds was no fancy upon my part, caused by their silence, for many birds cease singing when nesting is well over, but was absolutely true of them. Careful search failed to trace them, as they had evidently left the neighborhood. The six weeks of summer following the middle of July prove to be an interval not in the summer sojourn of those that nested here, though it seemed so, because the chats that about September 1st appear again in our woods and thickets are not our old friends, but are new-comers that have reached us from more northern localities. Those that nested here, returned to their winter homes when nesting was over; while those that are seen here in September are those that, having nested farther to the north and later in the season, are now on their return to their winter-quarters.

Thus, it will be seen that the chats that nested in the valley of the Delaware River returned south as soon as nesting was over; while a little later, the birds from the Hudson and Connecticut River Valleys came hither and occupied, for a brief period, the then chat-deserted Delaware Valley. These again proceed leisurely, in their turn, on their way, often lingering long in the golden sunshine of sweet September days, but never singing those ecstatic spring-time notes that fairly start the echoes of a bright May morning.

In brief, the autumnal or return migratory movement of our inland birds really commences in midsummer and is from valley to valley, and therefore a gradual change of base, along the whole northern Atlantic seaboard.

I have frequently observed the same thing in the movements and habits of the indigo bird. In this case, also, there is often a well-marked interim, say from the middle of July to the beginning of September. This can not be explained away by suggestions of slight changes of locality, as from uplands to swamps, or open country to wooded districts. It is, rather, an interim caused by the departure of those that nested here in May and June for some more southern locality. These birds seem to move with the regularity ascribed to swallows, and I doubt if one in fifty of those that are seen as late as September were here during the nesting-season. These late birds, too, do not haunt the brier-patches, high weeds, and like spots; but stay closely among the taller trees, and near their very tops at that, sometimes essaying a feeble imitation of early summer warblings. More often this song is now but the ineffectual efforts of young birds to anticipate their future capabilities in melody.

Other equally marked changes in habits on the part of other birds may be mentioned as further evidence that migration is more gradual than has been supposed. As early as the beginning of August both species of orioles have left their spring-time haunts. Occasionally a male will be seen pausing on the top of some tall tree, and whistling as he tarries for a moment; but where are now the numbers of old and young birds that nested or were reared in the many pendent nests in the elms and willows? Unlike the chats and indigo birds, the orioles do not all depart from the land; but, congregating in loose flocks, they associate intimately with the reed-birds, that are now gathering by the thousands in the uplands, preparatory to seeking the reeds on the river shore. Here the orioles will remain until the second or third sharp frost. Again, those very unlike birds, the king-bird and blue-bird, will together form loose flocks and congregate in the meadows. This is the more difficult to understand as the king-bird is strictly migratory, while the blue-bird is only partly so; and I am positive that the flocks of the two species that haunt the meadows until October are broken up at last by the king-birds passing southward and the vast majority of the blue-birds returning to the uplands, where they remain the winter through, seeking shelter from the more violent storms in the dense foliage of our common cedar.

These changes of habit, comparing May and June with August and September, have doubtless been brought about by the all-important question of food-supply, and in the instance of the birds last mentioned, may be looked upon as the first step in the return migratory movement, especially as it is a change from higher and cooler uplands to the low-lying and warmer shores of the southward-flowing river, from near the mouth of which these birds make an easy overland journey to the valley beyond. In this way, long before winter sets in in the New England and Middle States, many of our spring birds have completed their return journey home—for home it is to them when they near the tropics or enter them.

If we consider the several circumstances that would necessarily influence migratory movements, this actual irregularity in autumn is just what might be expected, but in the spring, when every bird, if possible, returns to its own home and former nest, they will not linger on the way, as they know too well the length of the journey before them. The coming duties of incubation, too, speed them on, and we wonder why they are not more regular in their movements. In autumn all this is changed. Now nothing need hurry them, and, so long as they find an abundance of food, they move along leisurely, just keeping ahead, as it seems, of the chilling frosts of the coming winter, which they can easily endure, but which robs them of the food they must have. This is especially true of insect-eating birds. Considered in this light, we are not surprised to find, then, as a rule, that the warblers, swallows, and such other birds as depend wholly upon insects for their sustenance, leave more promptly, and in larger numbers at one time, than do the granivorous birds and those that can subsist on seeds, though they consume insects as long as they can find them.

The weather, both during September and October, is exceedingly variable, although never really wintry, and this fact makes the southward movements of the migratory, insect-eating birds equally so, inasmuch as these birds are not larvæ-hunting species, but depend upon insects that can be caught upon the wing, or are to be found resting upon the leaves and twigs of the trees. Therefore, just so long as the heavy white frosts are delayed, these insectivorous birds will linger, or move southward in the most leisurely way. Up to a certain time, usually about the middle of October, these birds largely increase in numbers, consequent upon the daily accession of those from the north, and after the maximum is reached, their number steadily decreases, until but a few stragglers remain.

I feel quite confident that in exceptionally mild seasons many more migratory birds winter in southern New Jersey than ornithologists suspect; and I can see in the lingering remnant of the great flight of warblers that annually pass through the State that gradual adaptation to surrounding conditions, on the part of birds, that as centuries roll by, evolve, by that mystery of mysteries the survival of the fittest, new species from the old.

Again, long after the true insect-eaters have passed southward, beyond the limits of the State, and scarcely a leaf is left upon the forest-trees, when not one straggling fly-catcher, in a day's walk, can be found hovering about the many spots so lately tenanted by myriads of their kind, we have yet the pleasure of seeing in our rambles many a blithe sparrow, restless tit, or noisy nut-hatch, either in the fields or about leafless hedges, or haunting the still green but nearly deserted swampy meadows; or high up in the lofty pines, and amid the thickest branches of the gloomy cedar, we may chance to find hosts of merry linnets, full of song, or fiery kinglets that scold like wrens, should you approach too near.

Of our many sparrows, of which several are resident species, I have noted down for several years, when the severity of the winter was yet to come, even as late as the middle of December, the presence of three or four species that may be considered as migratory. For instance, in the wet, reedy meadows, it is not until winter has incased in ice the tangled grasses that the sharp-tailed finch and swamp-sparrow quit their home. In 1872, and again in 1874, which latter year was the most remarkable for the number and variety of birds of any in my memory, I noticed that in the dry, upland fields, all through November's hazy Indian summer, the sprightly, black-throated bunting remained, in little companies;

and in the quiet woodlands several retiring grosbeaks were seen until biting north winds drove them from their summer haunts. The bobolinks, in spite of the persecution they suffer from sportsmen, hold to their reedy haunts, in scattering pairs, often until the first fall of snow, and, this same bird being occasionally seen very early in the spring, may possibly remain during the winter, but if so, it is very rarely. A few red-winged blackbirds, we know, do withstand our winters, and seem to find food somewhere and somehow, even when the thermometer is at zero.

The difference between the insect-eating and the seed-eating birds, in the more prolonged stay of the latter, is, I think, easily explained. In the spring, when birds journey north, there is an object ever in view, whilst in the autumn, their sole care is to be at home in time, not so much to escape the coming cold, as to avoid being pinched by hunger.

We have seen that the first frost, though it affects vegetation but little, does materially decrease insect life; the swallows, as a rule, even anticipate it, and gathering in immense flocks they wing their way southward before it comes. From this, we can clearly see that the weather greatly influences, indeed governs, the migratory movements in autumn of the insect-eaters. It bids them depart, and, in general, they heed the bidding; but long after this, while there are yet berries, seeds, and fruits to be obtained, the migratory vegetarians linger by the way, in varying but considerable numbers.

Let us now glance at the abundant and well-known purple grakle or crow-blackbird. The numbers of this, with us, partly migratory species which remain throughout the winter, as compared with those which are here during the spring and summer months, are about as ten to one thousand, as near as I can judge; and, in proportion as the winter is mild, the percentage of those that remain is increased. In Massachusetts, this bird is strictly migratory, the great bulk of those that depart from the north and from New Jersey wintering in the Carolinas and Georgia. In this species, therefore, we have an example of a migratory bird that is gradually becoming more and more accustomed, not to the rigors of winter, which birds are better able to withstand than they are generally supposed to be, but to the methods of our winter residents, such as wood-peckers, jays, and titmice, in procuring seasonable food. As a matter of course, food, and an abundance of it, must necessarily be obtained, and, on examination of the stomachs of grakles killed in January, I have found them filled with a half-digested mass of what appeared to be both animal and vegetable matter. If the grakles that remain during the winter are of a hardier constitution than those that migrate, then, as they mate very early in the year, and before the great bulk of the southern sojourners reach us, their offspring will naturally inherit equally vigorous constitutions, and, like their parents, will be more disposed to remain—at least, a large proportion of them will be—and in this way, wholly through natural selection, a race of grakles, otherwise undistinguishable from the whole number of this species, will be evolved, that in time will replace, in great part, the now migratory and semi-migratory individuals. If I have correctly explained a change now in progress, in the habits of this and other species, then can we not from it gain a clew to one, at least, of the original causes of the habit of migrating?

The act of migrating being the passage from one distant point to another, it is evident that the cause or causes of this movement, as the case may be, operate at either terminus of the journey. A warbler that winters in Florida and breeds near the Arctic circle is influenced by a cause that exists at each terminus, or rather by two differing causes, each peculiar to the location, for it is wholly incredible that it is the same cause that induces both the visit to northern regions and the return to a southern clime; therefore there must be at least two reasons for the habit—one inducing the bird to migrate northward in the spring, another compelling it to return in the autumn. If it be possible now to demonstrate what these causes are, and how the same cause can influence all migratory birds, considering that their habits are otherwise so totally different, it will not then necessarily follow that it was the originating cause of the habit. When, indeed, did this migration commence? How far back into the world's geological history must we go to trace the first bird that was forced to seek another and far-distant land wherein to rear its young and find for its offspring and itself sufficient food? What conditions of heat and cold, land and water, summer and winter, then obtained, that birds must needs fly from coming rigors of scorching sun, or ice and floods, or perish where they were? Was it from living in such a world that migration originated, and became, strangely enough, characteristic of only a fraction of the whole number? How, too, could birds have learned the oncoming of disastrous times, and know just where to seek a safe harbor and secure rest? Clearly it could have been only by a very gradual accumulation of experiences extending over many generations, before the few progenitors of our many birds gained the happy knowledge that here in the north we have months of sunny summer weather and a wealth of pleasant places. I shall not go back, then, of the Glacial period, but rest content with it as having been the starting-point in time of birds' migratory movements. The progenitor of our score of warblers, the one tyrant flycatcher, from which all our species have sprung, the vireos, the goatsuckers, and cuckoos, then very few in species, if indeed there were more than one of each, must have been influenced by the presence of the icy barriers that shut them off for the time being from a vast portion of the northern world, and at the close or closing of that wonderful period it may be that migration commenced, yet why and how it is hard even to conjecture. Knowing that it commenced then or recommenced, if previously a feature of bird life, we have now to inquire what are its apparent causes at present; but, before inquiring into these, may we not, after all, ask if migration be not an inherited habit, the originating causes of which are not now in operation? The conditions not obtaining that necessitate migration, does it not become a case of survival of habit, just as in man many customs now exist, the origin and proper meaning of which are wholly lost? That this is true of the migration of all birds I do not believe, but that it partially holds good with some species I am fully convinced. As an inherited habit, but one now not absolutely necessary to the birds' welfare, I can see why it should be, as it frequently is, so greatly influenced by surrounding circumstances and conditions.

Taking the movement from its proper starting-point, which I assume to be the movement from south to north in the three spring months, we must now look for sufficient causes to induce the undertaking of such long journeys. These causes are suggested by the two principal objects effected on their arrival at their northern destination—the rearing of their young, and procuring suitable and sufficient food for both themselves and offspring. If migration is for these two purposes only, then it should prove to be the case that food was not sufficiently abundant in the south for both its resident and migratory birds. This certainly could not have been the case, and I believe, therefore, that migratory movements, at the outset, were very limited in extent, and consisted only of a few birds at a time, which, seeking to avoid their enemies and have undisturbed possession of a locality, pushed out from their accustomed haunts for, comparatively speaking, a few miles. The young of such pioneer birds would naturally leave the neighborhood of their nest and return to their parents' usual haunt with them; but, on the return of another breeding-season, they would themselves seek a nesting-place near where they themselves were reared, and the older birds would go to the same nest or nesting-place that they previously had occupied. This is precisely what occurs now, year after year. Now, as birds increased, century after century, the limits of this northward movement would be extended, until it became in time the journey of thousands of miles that it now is.

Assuming, then, that migration arose for the dual purpose of safe nidification and a certainty of sufficient food, we are met by the ugly question, "Why do not all the southern birds come north?" If, when the whole avi-fauna was concentrated at the south, there was any struggle whatever for favorable feeding- or breeding-grounds, then, naturally, the weaker would go to the wall, or, in other words, would be driven beyond the limits of their accustomed habitat. These weaker birds, taken together, having once formed the habit of visiting certain localities at stated times for given purposes, or being periodically forced to do so, they would vary in their methods of reaching these localities, in their choice of regions wherein to remain, and in the length of their annual visit, just in proportion as their habits generally varied from those of both other species of the same family and from species of other families. For instance, to avoid a common enemy, a number of species might have gradually learned to migrate at night; while others, although forced to migrate, had not this same enemy to contend with, and so traveled only by day. In this way the habit of nocturnal migration would long ago have been formed, and it would, by inheritance, be continued by their descendants, even after the enemy had been long extinct.

Having reached their northern summer homes, and, free from molestation, reared their broods, clearly, if all things needed for their comfort were to be obtained, it can not be supposed that these same birds would unnecessarily retrace their long flight to the distant south. This suggests that, if I am correct in assuming that birds first appeared in a tropical climate, and from such climate migration started, it is probable that, by gradually prolonging their northern visits and accustoming themselves to northern insect and vegetable life, these regions became populated by their resident species. It is evident that the present migratory species are simply compelled to return, and three compelling causes are demonstrable. Primarily, the sudden increase of cold at the close of the brief northern summer, which starts southward those farthest at the north. This accession of intense cold necessarily decreases the amount of food, and the birds are now forced to find it elsewhere. Farther and farther south they come, just in advance of the cold, and slower and slower they proceed as they enter our more temperate latitude, and here, resting as it were, they linger until a keen frost kills their insect-food, and, scattering the leaves, robs them of their main shelter from their enemies, happily fewer now than formerly, and now still southward they proceed, until they reach a home in lands blessed with perpetual summer.

I have now traced these migratory species from south to north, and back to their southern habitat, and endeavored to point out the several operating causes of the movement as I did so. I have already suggested the possibility of migration being an inherited habit not now necessary. Now, be this true or not, it is evident that the habit is not so fixed that ordinary changes in surrounding conditions do not greatly influence it. This, I think, is shown by the irregularity of the movement that really occurs, and the tendency on the part of many species to modify the habit by occasionally halting much to the south of their usual breeding-grounds, and by remaining later and later in autumn; and, again, by the fact that many birds are now only partially migratory, and that others occasionally migrate simply in search of food, irrespective of seasons, thus exhibiting, as it were, traces of a habit they have long lost.

In the migration of a bird, then, I see simply a temporary sojourn in a distant locality for the purpose of rearing its offspring in safety; the cause being implied by the term "safety," that is, freedom from enemies and an abundance of food.

CHAPTER XIV.

A SHORT STUDY OF BIRDS' NESTS.

HAVING read with great delight Mr. Wallace's essays on the "Philosophy of Birds' Nests," and his theory concerning them, it occurred to me to see how far his views were applicable to the hundreds of nests that were yearly built in my favorite haunts about home; for, whether I rambled by the river's shore, or the wooded creek-bank nearer by, in the open meadows or the upland fields, by the weedy angles of the zigzag fences, or in the depths of the woods, I soon noticed that, whatever else might be wanting, some one kind of bird, at least, had found in every locality a fitting place for its nest.

At first, there appeared to be such a similarity in the nests that I almost came to the conclusion that birds could only construct them in one manner, and were incapable of varying from it; that they did not exercise any judgment in the work, and that to-day their nests were but fac-similes of those built by their remotest ancestors in the indefinite past.

This idea of fixedness of habit was formerly very generally, and to a limited extent is still, taught as true not only of birds but of all animals. It is the natural outcome of the old creative theory of life, and is, I need scarcely add, utterly false.

Whatever may have been the peculiarities of the original bird-like creature, before losing reptilian and assuming decidedly avian features, it certainly bore no resemblance to any living bird, the oldest form of which was long since evolved from a still more primitive avian, and at the same time distinctively reptilian, creature. These changes having been wrought in the birds themselves, it would be strange indeed if there had not been a corresponding want of fixity in their habits.

As to the general correctness of the views of Mr. Wallace concerning the motive that causes certain birds to build nests of a particular pattern, I have no criticism to make. Suffice it to say, that the results given in the following pages will show that, to a certain extent at least, his views will apply to our birds. With these cautionary remarks we are now ready to take up the results of my short studies of the nests themselves, which were originally made several years ago, but which have been verified during each succeeding summer.

Having carefully examined the nest of a particular kind of bird, which seemed to agree most nearly with the published descriptions, I then noted each nest found, and marked the amount of variation in the construction and position. Take, for instance, the nest of our common robin. Here we have a nest largely constructed of coarse twigs and grass, lined with a "cup-shaped fabric of clay or mud," this mud being covered with finer grass, horsehair, and occasionally a few feathers. It is an excellent nest to study, as it shows fully the amount of variation practiced in their construction. During the spring and summer of 1873 I found thirty-two of these nests in an area of about four hundred acres. Of these thirty-two I shall speak, principally with reference to the care exhibited in the mud lining, and refer but incidentally to their positions. Eleven of them were what might be called "typical"; as in them the mud lining was complete, extending to within an inch, or a little more, of the rim or top of the structure.

In fourteen, the mud lining was more or less incomplete, although it always extended over the bottom of the nest, or of so much of the interior surface as was necessary for the eggs or very young birds to rest upon. Without an exception, the fine grass and hair lining the interior of each nest were in greater proportion as the mud lining was imperfect, so that, in some instances, the mud being concealed, the nests were very similar to those of other thrushes.

The remaining seven nests were "abnormal," each of them occupying a different position from that which the robin is usually supposed to select. A careful study of the surroundings, however, showed that there was always some outside advantage, such as immediate proximity to abundant food, which may have had some influence in the choice of location. As an instance, one of these seven nests was placed in a deep cleft in the trunk of an apple-tree. It had a southern exposure, was protected from rain by the trunk and branches of the tree, and altogether was admirably located. But, as the tree itself had an abundance of branches, which for many summers had had robins' nests among them, there seemed to be some reason why this particular location was now occupied for the first time. What was the cause of this change from the branches to the cleft I could not discover. The nest itself was merely a few coarse twigs, projecting about two inches from the trunk of the tree, and intended for the necessary support of that portion of the "clay fabric" not resting upon the tree itself. When completed, the structure much resembled a modified cliff-swallow's nest, such as these birds build under the eaves of barns.

If now, as Mr. Wallace has pointed out, and, as I believe, conclusively shown, young birds build their nests through imitation, then the young robins reared in this nest will seek out somewhat similar situations for their own nests. Should such a locality not suit the bird's mate, then a more exposed position would be chosen, as is usually the case, and some of the peculiarities of the nest in which one of the pair was reared would, I doubt not, be retained. If, however, it should happen that the pair in question were brother and sister, then it is probable that an identical nest would be constructed, if a similar locality could be found. Notwithstanding the wandering disposition of our robins, it can be shown that the same pair, year after year, return to the same locality to build; and if they, or indeed, if birds of any kind remain together, or having separated they come again together, year after year, there is no reason why the brood of one year may not become more or less associated during the ensuing spring, when they may mate and construct nests of their own. I am very positive that this in-breeding occurs very often among resident species, and with no ill effects. We see it constantly, too, in our domestic pigeons.

In comparing the eleven typical nests of the robin, it could not but be noticed that minor differences or peculiarities existed. These small variations were in size, which was in fact considerable; in shape, some of the nests being oval rather than circular; in the choice of material for the interior lining, and, in one case, this lining, I am sorry to say, was surprisingly like that of a chipping-sparrow's nest, and had probably been stolen. Indeed, among robins, as well as among all other birds, there are individual rogues, as well as cross-grained, scolding wives and husbands.

Taking a careful survey of the whole thirty-two nests, they suggested at once an ordinary village: there were, for instance, handsome structures, and then again very modest ones; and while, perhaps, strictly speaking, the causes that produce this variation in the dwelling-places of birds are not the same as those which lead to a similar state of affairs among mankind, yet in a remote degree they are believed to be in many respects analogous. For instance, there are industrious birds and lazy ones; plucky birds that are not daunted by obstacles, and despondent ones that are cast down by shadows; and this of itself will account for a great deal of the variation in birds' nests. That birds differ greatly in their temperaments can hardly be doubted, and, if this be admitted, may we not go a step further and claim also differences in mental capacity, or, in plain language, may we not say that the "smarter" the bird the better the nest?

Why these nests of the robin vary, simply is—a mud-lined nest being that which formerly, if not at present, was best suited to the bird's welfare—that a bird reared in a poorly constructed and partially lined nest may prove to be of greater ability and more energetic than its parents, and this, joined with the fact that the bird's mate may have been reared in a nest of perfect construction, of itself, would tend to remedy in part the defects in construction that its partner might allow; the facts together would certainly secure an approach to, if not the complete attainment of, a typical robin's nest. So, as the years roll by, the nest of the robin would remain substantially the same; but what slight variations circumstances have caused to be made, if not detrimental, would also be continued, and, if any marked changes of environment occurred, increased.

Why, indeed, a robin should line its nest with mud, and its near relatives, the wood-thrush and cat-bird, should not, is not known; but as changes gradually brought about by man's agency have already effected changes in the habits of some of our birds, so these same changes, ever in progress in the haunts of the robin, may cause these birds to gradually omit this lining of mud, and so make their habitations more like those of other thrushes; just as the cliff-swallow, with us, no longer places a "bottle-neck" opening to its mud-built nests.

There is an instability in the whole range of the habits of birds going hand-in-hand with the undoubted tendency to variation in their anatomical structure, excessively slow as this is. Natural selection, or whatever may be the determining influence that governs it, controls as surely the range of variation in the details of the construction of their nests, inasmuch as these variations are the inevitable results of changes wrought in the physical construction of the creatures themselves. Stripped of the haze that metaphysics has gathered about it, the operations of the mind, whether in man or bird, are only the curious results of the working of those fatty atoms, intimately combined, which we call the brain, and by no argumentation can the two be separated. They are just as interdependent, and as much parts of a single whole, as the eye and sight, the nose and smell, hearing and the ear, the circulation of the blood and the beating of the heart.

A nest of a totally different character, that of the Baltimore oriole, was more carefully studied, inasmuch as it afforded more marked variations from what may be considered the typical form of such a structure.

In the essays by Mr. Wallace ("On Natural Selection," by A. R. Wallace, London, 1870, p. 211 *et seq.*), the conclusion is drawn that, where a nest is so constructed as to conceal the sitting bird, the occupant, in all such cases, is of bright, showy plumage, and would easily be detected by birds of prey, if not concealed when on the nest. Of the family *Icteridæ,* to which the Baltimore oriole belongs, Mr. Wallace says: "The red or yellow and black plumage of most of these birds is very conspicuous, and is exactly alike in both sexes. [This is not true of the Baltimore oriole, the female of which is much less brightly colored.] They are celebrated for their fine, purse-shaped, pensile nests." Now, there are two considerations worthy of attention with reference to this bird and the character of its nest. In the first place, as the male bird is much brighter than the female in its plumage, would it not require a concealing nest if it assisted in incubation? Now, does the male bird take part in covering the eggs? Unquestionably it does. Secondly, if the bird-concealing nest, a "pendulous and nearly cylindrical pouch," is constructed solely with reference to the protection of the parent birds, would it not be within the range of probabilities that, no danger existing, the labor of constructing so elaborate a nest would be abandoned? Has this actually occurred?

During the summer of 1872, I found nine nests of the Baltimore oriole within a comparatively small area; in 1873, I succeeded in finding seventeen nests in an area nearly ten times as large; and during the summer of 1874 I found thirteen nests in an area of the same extent as that examined in 1873.

These thirty-nine nests I classified as follows: of the nine examined in 1872, six were so constructed as to effectually conceal the sitting bird, and three were sufficiently open at the top to give a hawk hovering above it a view of the occupant.

Of the seventeen which I found and inspected during the summer of 1873, eleven were "bird concealing" in their shape, and the remaining six like the three I found in 1872—i. e., were open at the top.

During the summer of 1874, Baltimore orioles were unusually abundant, and of the thirteen nests found, eight were open at the top, and five were long, pendulous pouches that wholly hid the sitting bird.

Bearing in mind the supposed reason for building a nest that would conceal the parent birds when occupying it, I noted down the exact location of each of these thirty-nine nests. In every instance, those that concealed the sitting bird were at a considerable distance from any house, in uncultivated parts, the larger portion being on an unfrequented island; the others were on elm-trees growing on the banks of a lonely creek. In both these localities sparrow-hawks were seen frequently, when compared with their appearance in the neighborhoods selected for the building of open-topped nests, all of which were in willow and elm trees in the yards of farm-houses, and in full view of people continually passing to and fro.

The conclusion drawn from the study of these nests was, that the orioles, knowing that there was in this case but little danger from hawks, constructed a less elaborate nest, one which answered every purpose of incubation, though it did not conceal the parent birds when occupying it.

Of the nests that did not conceal the sitting birds, every one was widely open at the top, and the bird entered from above. The weight of the bird when in the nest appeared to draw the edges of the rim together, but not so as to shut out all view of the occupant. The rims of those nests that when occupied concealed the birds were all much smaller, and the nest itself was deeper, than were any of those nests where concealment was not considered in the construction; these latter being in every way much like the ordinary nests of the orchard oriole.

Originally, in all probability, when its enemies were more numerous, especially the smaller hawks, the nest of the Baltimore oriole was perfectly closed at the top and had an opening at the side; but, of the hundreds of these nests that I have seen, I have never yet found one that was constructed in this manner.

Perhaps as great a change in the manner of constructing nests as that given in the case of the Baltimore oriole is shown in an instance that occurred under my notice in 1875, and has since been repeated every year (1880) by, probably, the same pair of birds. This is the construction of a semi-globular, supported nest, in a pine-tree, by the orchard or bastard orioles. The materials used in building it were the leaves of the pine, or "pine-needles," as we call them. A few strands of long grass and a bit or two of thread entered into the rim of the nest, and seemed merely to outline the top and hold together the slight twigs to which the nest was attached. The pine-needles were woven into a basket, and supported by a stray thread or a single long, flexible blade of grass, placed here and there through the nest. The bottom of the structure rested on a twig, so that in no respect was it suspended. While ordinarily these orioles build a less carefully constructed nest than does the Baltimore oriole, still it is usually suspended, and made of long, flexible grass, closely interwoven. The nests in the pine-tree, on the other hand, were remarkable for the almost total absence of any suitable flexible materials. This could not have arisen from their absence, as Baltimore orioles built three nests in the immediate vicinity, and had no trouble in finding as much long grass, hair, and bits of twine as they needed.

The nest of the orchard orioles made of pine-needles was rebuilt in the pine-tree in precisely the same manner in 1878 and in 1879. In 1880 two such nests were built. In 1876 and 1877 the nests were built in apple-trees near by, and pine-needles were used. Why the pine-tree was deserted for two years is to be explained by the fact that, in those years, a colony of purple grakles occupied that and the adjoining trees during the nesting season; and, considering the noise they made, night and day, it is scarcely to be wondered at that the orioles should seek other localities for their summer home. The grakles did not appear in 1878 and 1879, so the orioles again had the pine to themselves while nesting. In 1881 and the past summer, 1882, the grakles were back, and no orioles nested in the pine; but I found a nest of theirs in a pear-tree near by, and this, like all the others, was made almost wholly of pine-needles.

The present nesting-habits of the chimney-swallow are worthy of some consideration, in connection with the subject of variation in the nidification of birds. It may be laid down as a fixed habit of this bird, that, at present, it constructs its nest only in chimneys. The exceptional cases that have been mentioned recently are too few to render qualification of this statement necessary. Now, as chimneys have been available less than three centuries, where, prior to this, were the nests of this bird placed? Peter Kalm says of these birds, writing one hundred and thirty years ago: "They derive their name from nests built in chimneys which are not made use of in summer: sometimes, when the smoke is not very great, they do not mind the smoke, and remain in the chimney. I did not see them this year [1749] till late in May, but in the ensuing year [1750] they arrived on the 3d of May, for they appear much later than the other swallows." (This is not true of them at present. They invariably follow the bank-swallow, and precede by several days the rest of the swallow tribes. The chimney-swallow, furthermore, is not a true swallow but a swift, birds of a very different family, but with similar habits.) It is remarkable that each feather in their tail ends in a stiff, sharp point, like the end of an awl; they apply the tail to the side of the wall in the chimneys, hold themselves with their feet, and the stiff tail serves to keep them up. They make a great thundering noise all the day long by flying up and down in the chimneys; and, as they build their nests in chimneys only, and it is well known that the *Indians* have not so much as a hearth made of masonry, much less a chimney, but make their fires on the ground in their huts, it is an obvious question, Where did the swallows build their nests before the *Europeans* came and made houses with chimneys? It is probable that they formerly made them in great hollow trees."

This view of Kalm's is correct, as is well known. I had the good fortune in 1869 to find a "great hollow tree" in a piece of woodland that was thus tenanted by a colony of these birds. The nests did not vary at all from those found in chimneys. I judged the cause of this return to the old-time habit of nesting in trees was the fact that the chimney of a small house near by, in which the swallows were accustomed to build, had been closed to them by a wire netting, and, as the nearest available chimneys were all tenanted by swallows, these "shut out" birds were forced to seek some available locality in a tree or crevice of a rock, or else quit the neighborhood. Accepting the only alternative, they availed themselves of a hollow chestnut-tree, where they were, to all appearance, as well suited as they would have been in their former haunts. My curiosity was roused to know what the following summer would have to show. Would they return to the tree? In April and May of 1870, I carefully watched for them, but not a swallow appeared.

The nests of the chimney-swallows, when placed in hollow trees, are, of course, greatly exposed to the attacks of owls and such carnivorous mammals as are good climbers, and it is highly probable that, in the case of these birds, we have an instance of birds thriving better and increasing in numbers, in consequence of the environment being greatly altered by man's agency. The habit of building nests of a particular pattern and many together has remained the same; but, the artificial localities offered being a great improvement over anything in Nature, the birds have been correspondingly benefited.

CHAPTER XV.

THE SONGS OF BIRDS.

During the spring and summer of 1874 especially, and at all favorable opportunities since, my out-door studies were largely confined to particular phases of bird-life, rather than to their habits generally. Most prominent among these was that of singing, and its relation to the other utterances of birds; for I had been long under the impression, and since am fully convinced, that a bird's song bears just the same relationship to its various chirps. twitters, and calls, that singing with mankind bears to ordinary conversation.

Early in the morning of any bright May day, passing, on my lookout for new arrivals among the migratory birds, along some woody slope glistening with dew and glorious in floral decoration, I am greeted by a loud chirp! In an instant a hundred melodious voices are hushed, and not until I have remained quiet for several moments is the concert resumed; then the bird that gave this warning call seeks some more elevated perch, and, with head erect, he again takes up the strain. Another and another songster joins in the chorus, and again the woods ring with the united voices of thrushes, wrens, sparrows, and warblers beyond count.

It may be objected, at the very outset, that all are not singing birds, and the fact of non-singing birds outnumbering the others disposes effectually of my theory.

"Whoever heard an owl sing?" is asked in derision. Well, my good friend, do you call the shrill, cacophonous shouts of savages singing? Yet we know that to these same savage peoples their weird cries and monotonous drumming are as melodious as the best efforts of a prima donna are to us. While, as we understand melody, some species of birds are endowed with marked musical abilities and others are devoid of them, it does not follow that the latter have not a series of notes or utterances pleasurable to themselves and to their fellows. To deny this is really to assert that some birds are gifted with song for man's pleasure instead of for their own. This is a common expression, I know, but it is utterly absurd. Careful observation will enable any one to see clearly that every bird has a considerable range of utterance, which is divisible into cries or expressions of various kinds, each, of course, having a different and uniform meaning. Some of the low, monotonous notes of brooding birds are evidently uttered for their soothing effect upon themselves, their mates and young, and are only heard during the nesting season. The truth is, a bird can only be rightly understood by a bird, and a naturalist must spend years in patient watching, often for days together, and must have made himself familiar to the birds, before he can witness a tithe of the many acts which go to prove that they approach nearer to reasoning beings than is generally supposed.

Space does not allow me to give all the details that I have jotted down during my rambles about home, and I must content myself with an occasional extract from my note-book, in the effort to interpret briefly the songs of many of our birds.

Including some twenty species of warblers, more or less regular in their yearly appearance, there are in Central New Jersey fifty-four birds, resident and migratory, that can be considered as strictly singing birds. These may with perfect propriety be classed in accordance with their peculiar temperaments, as VIVACIOUS, SPRIGHTLY, or DULL; meaning thereby to express three degrees of animation in their songs. As instances of the first may be named the house-wren and Baltimore oriole, the song-sparrow and indigo bird belong to the second class, and in the third are to be found the bluebird and the peewee. Now, the songs of these birds can not in any sense be looked upon as a uniform series of notes—a stereotyped whistle or an unvarying warble, as is said of them by the late Dr. Holland in the following stanzas:

"The robin repeats his two musical words,
The meadow-lark whistles his one refrain;
And steadily, over and over again,
The same song swells from a hundred birds."

"Bobolink, chick-a-dee, blackbird, and jay,
Thrasher and woodpecker, cuckoo and wren,
Each sings its word or its phrase, and then
It has nothing further to sing or to say."

But, as a matter of fact, they do have other songs to sing, and do find plenty to say when occasion requires. While as a rule the song of any bird, when once known, can usually be recognized when heard a second time, yet this is not always the case, for the reason that our songsters do, at times, vary their notes in the most striking manner. This is such a frequent occurrence, and is so universally true of our song-birds, as effectually to disprove the assertion that they have "nothing further to sing or to say."

As has been said, the various songs of the fifty odd kinds of singing birds can be readily placed under one or the other of these three headings; and, curiously enough, in every case the song is indicative of the character of the bird or *vice versa.* Unquestionably there is a close connection between the song and temperament; in fact, it may be laid down as a law that the latter decides the character of the former. This has, I think, a strong bearing on the question of the origin of the songs themselves, as I do not entertain the suggestion that some birds were created songsters, while others were denied this power. Rather, it seems to me that, from cries of alarm, and quick, hearty chirps expressive of satisfaction, there have been evolved the melodious notes of our most accomplished songsters. Why may not this be so? Certainly by analogous processes our present civilization has produced in time the elaborate music of the present day, from the harsh, discordant attempts at melody on the part of existing savage races, just as they were the outcome of still ruder sounds in which man's primeval, pre-human ancestry indulged.

Let us now consider for a moment one fact in regard to these songs that separates them from the other utterances of birds, and that is, that the bird sings solely for the pleasure of listening himself, or of being listened to by his fellows, and the song bears no relation whatever to any of his preceding or subsequent movements. From this it would appear that the song of a bird is an expression that gives pleasure to the bird itself and to others of its kind, which latter fact is recognized by the singer, and thus affords him additional satisfaction. In brief, the reason that birds sing is precisely the same as that which induces man to cultivate music, which, by the way, was originally exclusively vocal.

We shall now turn to the other class of utterances of these same birds, and carefully note them down in all their variations. There is in them material for months of careful study, and any one who has an opportunity to listen to a pair of newly-mated birds will be struck with amazement at the great variety of sounds, all evident expressions of the varied mental impressions of the moment. These "notes," as we may call them, are usually low, and many are scarcely audible, unless we happen to get very near the birds and yet remain unseen.

In this whole class of sounds other than the true song, we have a guide to their proper interpretation in the very evident fact that all such single expressions, as chirps, trills, twitters, and shrill cries, are always accompanied by movements which are closely related to them. A bird singing, except during courtship, when gymnastics are indulged in, does not busy itself with anything else at the same time. Thus, for instance, if busy feeding, at the moment of inspiration, it quits its search for food, and, taking up a suitable position, it begins its song and keeps it up until wearied with the repetition or called by its mate, or, struck by a sudden thought, away it goes, to work it may be, or else it flies off to some distant place. When, however, it is busy hunting for food, the low chirps and an occasional twitter that accompany the search indicate, if alone, that it is talking to itself, or, if with company, that it is talking to them; for a bird surrounded by others, or in company with its mate, will chirp more loudly and with a greater variation of notes than when alone. If disturbed at such a time, how different an utterance is heard! Who can doubt the meaning of a frightened bird's alarm-cry? And how quickly is it responded to on the part of all the birds within hearing?

Probably the most marked instance of a difference in the habits that accompany the chirp and the song proper can be seen in the chewink or towhee bunting. This bird keeps upon the ground nearly the whole time. Its nest is always there, and its food is found under dead leaves lying upon the ground. Now, while it hops about, it utters, with much regularity and frequency, a double chirp, which has given rise to its local name, chĕ-wínk. A person might watch one of these birds for half a day and never suspect that it had any song or other note than the cheery chĕ-wínk, chĕ-wínk, it so frequently utters. It so happens, however, that it has a moderately sweet song, though it never yet was known to sing it while standing upon the ground. If moved to sing, it mounts upon a low bank or on the lower limb of a tree, and whistles, "*Chée-dò! chée-dò! tree-de-ré de-ré, de-ré!*" and then down on the ground it goes again.

The plain meaning of this, I take it, is that the chirps are not a song, nor are they intended by the bird as such, but that the more elaborate notes, uttered when in a bush or tree, do constitute his song, and this he sings for the gratification of himself and friends.

Again, observe two birds immediately after mating, and what a laughable caricature of a newly-married couple—say on their wedding journey—are their actions and their low ceaseless twittering! They also have their petty vexations and their little quarrels, in which the feminine voice is ever the louder and more rapid in its utterance, and its owner enjoys the precious privilege of the last word.

I have often witnessed such quarrels, and the literally hen-pecked husband has always been compelled to submit to his tyrannical partner. If he be lazy, woe betide him when nest-building commences, as it does so soon after mating. His gay feathers will soon lose their prim appearance, and mayhap only the fraction of a tail will be left him, but, in spite of all this, he will cheer his brooding mate with his choicest songs; singing, I have sometimes thought, with greater fervor from the consciousness that his wife is too busy at home to bother him.

But what has all this to do with language? Just this, that it depends on the manner in which things go on between the birds, whether the chirps and twitters are low, musical, and deliberately uttered, or whether they are shrill, cacophonous, and so rapidly repeated that the birds, if unseen, can not be recognized by their voices.

But it may be urged that, to constitute language, or something akin to it, these chirps and twitters must be shown to convey ideas. Can one bird tell another anything? it will be asked. To this I answer that, if any one has watched a colony of brooding grakles, or paid close attention to a flock of crows, he has probably satisfied himself upon this point. Crows have twenty-seven distinct cries, calls, or utterances, each readily distinguishable from the other, and each having an unmistakable connection with a certain class of actions; some of which, as, for instance, the many different notes of the brooding-birds, are only heard at certain seasons. In this connection, it may be added that the intelligence of crows is fully one half greater than that of any other bird in our fauna. Instances of the exercise of much cunning and forethought on their part are almost innumerable.

Let us see, however, if among our singing-birds there is not to be found evidence of an ability to communicate ideas, presumably by the aid of vocal sounds. Here is an occurrence that took place in my presence in the spring of 1872. A pair of cat-birds were noticed carrying materials for a nest to a patch of blackberry-briers hard by. To test their ingenuity, I took a long, narrow strip of muslin, too long for one bird to carry conveniently, and placed it on the ground in a position to be seen by the birds when searching for suitable materials for their nest. In a few moments one of the cat-birds spied the strip and endeavored to carry it off, but its length and weight, in whichever way the bird took hold of it, and he tried many, impeded its flight. After worrying over it for some time the bird flew off, not, as I supposed, to seek other materials, but, as it proved, to obtain assistance in transporting the strip of muslin in question. In a few moments it returned with its mate, and then, standing near the strip, they held what I consider to have been a consultation. The chirping, twittering, murmuring, and occasional ejaculations were all unmistakable. In a few moments this chattering, if you will, ceased, and the work commenced. Each took hold of the strip of muslin at about the same distance from the ends, and, starting exactly together, they flew toward their unfinished nest, bearing the prize successfully away.

I followed them as quickly as possible, and, reaching the brier-patch, never before or since heard such an interminable wrangling and jabbering. Had I not seen the birds, I doubt if I should have recognized them from their voices. The poor birds simply could not agree how to use so long a piece of material to the best advantage. If it had been shorter, they might have made it serviceable; but as it was, being neither willing to discard it nor able to agree as to its proper use, they finally abandoned it altogether, and so too they did the unfinished nest and the neighborhood.

From what has been said, I can not see how birds can logically be denied language. A hundred instances similar to this in the essential details occur every spring day, and they all prove that a bird has some means of communicating its thoughts to its companions; and, as we know that they have a large range of utterances, is it not presumable that these are in large part the media by which their thoughts are expressed? We can only judge by the same standard which we apply to man, and, when so judged, it must I think be admitted that birds have a spoken language.

We have also seen that these various utterances are only expressed when the bird is occupied, and that their songs proper are only sung when the bird is quiet or giving its whole attention to the act of singing, for the fact that they often sing while flying does not contradict this; and these facts, it is believed, are sufficient to show that birds, like mankind, sing for pleasure and talk from necessity.

My own observations have led me to this conclusion.

CHAPTER XVI.

CHATS AND WRENS: A SUMMER'S STUDY.

I FIRST saw the chat on Sunday, May 9, 1874. From the topmost branch of a tall locust he sailed, with unsteady wings and dangling legs, upward and outward for some distance, uttering a few harsh squeaks, and then alighting, he warbled a series of sweet, liquid notes, followed in turn by sounds like the yelp of a puppy, the squeak of a squirrel, or the dull creaking of a rusty weather-vane. Then, hopping from twig to twig, searching for insects, he added his own peculiar chirp, alternated with low yet distinct notes, quite indescribable, but all hollow, ghost-like, and gloomy. These weird, mournful groans, plaintive calls, and cries as of some poor creature in distress, would follow each other in quick succession, when, suddenly ceasing, an outburst of glorious melody would complete the strange series. Then, having regained his perch upon the topmost branch, the restless bird would remain quiet for a moment, when, with the same awkward, crooked flight, he would repeat the same series of strange and sweet notes, with some little variation of the uncouth sounds he selected for imitation.

While I listened, wondering what next would greet my ears, I was surprised, even startled, by hearing the same strange sounds repeated, but at some distance off. Another chat, farther down the path, was singing in the same strange way—another it must be, for the one first heard is still in sight on the same locust-tree, flitting carelessly about and apparently silent. Curious to hear the new-comer, I passed on, when the sounds were heard in the opposite direction. I retraced my steps, and now the strange medley came from the low bushes about me, and, while looking carefully for the unseen chat that seemed so near, there came floating down to me from the tall locust's topmost branch the same series of odd sounds and sweet warblings. The truth was now clear: the one bird had uttered every sound I had heard, and by his ventriloquism had for the time completely deceived me. My study of this habit and its use now commenced, and for long weeks I watched him, to test in every way his ability to mislead one by the exercise of this peculiar power. On the 13th of the month, a second chat appeared, and the two—for the new-comer was a female—quickly selected a suitable spot in a tangled mass of blackberry briers at the foot of the locust-tree, and built a commodious but roughly constructed nest. While his mate was sitting, the male chat seemed more animated than ever, and, jealous of every intruder, he "threw his voice" in every direction other than toward the nest whenever any one came too near. On concealing myself and getting very close, I found, by watching for an hour or more at a time, that when undisturbed they uttered fewer cries of other creatures, and seldom exercised their ventriloquial powers. Their song was varied and at times grand, but usually the cheerful notes were so intermingled with hollow, sepulchral tones, not of an imitative character, as to render the entire utterance far from pleasing. I never could so startle the bird that it would simply give a quick chirp of alarm and fly off. However suddenly I appeared from my concealment, there was an equally quick uttering of notes of distress such as I have described, coming from, it seemed, a point several yards distant. Vary my experiments as I would, it mattered not: the bird was thoroughly conscious of its ventriloquial power, and trusted far more to it than to flight to avoid and mislead any intruder.

How came this bird to possess so unusual a power? This I shall leave for others to determine, with this one suggestion: having closely observed a pair of these birds during the entire summer, I discovered that the habit is eminently useful to them, and is, I think, possessed by the male only, though upon this point I am not positively certain.

When it is recollected that many of our birds—notably the mocking-bird and cat-bird—mimic not only the notes of other songsters, but sounds of almost every description, and that perhaps all gregarious birds post sentinels to sound alarm on the approach of an enemy, it is evident that all the vocal powers of birds are not brought into play simply for their own satisfaction or for that of their mates; for there is a wide difference between a bird's song and its ordinary chirping and twittering. During the lapse of ages they have learned, through experience, something of the laws of sound, and they know fully as well as man does that certain notes can be heard at a greater distance than others. This is shown by the fact that birds, when giving an alarm-cry, utter the note with a penetrating shrillness, not common in any of their ordinary chirps or song. This knowledge of one of the properties of sound, simple as it is, is the starting-point in the acquirement of the power of mimicry, which is the intermediate stage between ordinary vocal utterances, including songs, and that ventriloquial power which we have seen is possessed in great perfection by the chat.

Now, as this bird imitates very many sounds, it seems clear that the simple power of mimicry must have been first gained, and that the ventriloquial power, or the power to repeat a sound so as to make it seem as if it were uttered somewhere else, was a subsequent acquisition. Such an addition to the power of mimicking other birds and the cries of small mammals would at once prove advantageous in misleading a pursuing enemy, as, for instance, a small hawk; and the chat would not be slow to learn this, and to profit by the knowledge. In this way a new habit readily becomes characteristic of a species, first locally, and then throughout the entire extent of its haunts.

A word in conclusion concerning the vocal powers of the chat. While it is true that these birds sing a good deal by day, yet it is not until after sunset and during the night, especially if there be a moon, that they are merriest; and a more joyous strain never came from the bobolink than that which is then uttered by the chats. But, alas! this melody is so often spoiled by a commingling of mournful sounds, that it is not surprising the Indians should have called them the "ghost-birds."

About the middle of June the young birds had left the nest, though they still continued with the parent birds, and were fed by them. From this time until August, when both old and young left the neighborhood, I failed to detect any attempt even at singing on the part of the young; and the more marked features of the song of the parent birds were but seldom heard after the young had obtained a sufficient flight-power to insure their safety. This would seem to lead to the inference that both the mimicry and the ventriloquism were exercised by the male for the purpose of securing safety to the young and to the female while upon her nest; as the occasional exhibitions of song on his arrival in spring were, I suppose, given at first for his own satisfaction, and afterward, when the females had arrived, these tests of his power were intended for their gratification.

Let us now consider a very different bird—one not common in New Jersey, or, at least, very "local" in its distribution.

About the middle of July, when most birds had long finished their nesting-labors, a pair of Bewick's wrens appeared in and about one of my out-buildings, and, in a day or two, having fixed upon a suitable spot, began to build their nest. As they were not at this time at all timid, I had abundant opportunities of watching them while so employed, and I must admit that there was nothing poetical in their *modus operandi*. After the first few strands of long, tape-like grass had been arranged upon a beam, the birds came to the spot together, each carrying a blade of grass or other equally flexible material. The female then sat in the unfinished nest, arranging the materials, while her mate brought others, some of which he apparently wound loosely about her. This continued until the foundation and sides were completed. When finishing off the nest the female remained in and about it, while her mate was in quest of such soft materials as he could find. These were simply laid in the bottom of the nest, and received no special attention until a considerable quantity had been piled up, when the female burrowed into it, and, as I judged, kept turning round and round in it, until she had succeeded in making a comparatively smooth depression in it, just fitted to her body. The larger strands on the outside, which had heretofore appeared of no use, were now rudely twisted into the sides of the nest and carried up until they formed a sort of arch, scarcely close enough to form a roof, or to make of the entire structure a globular nest, like that of the marsh-wren. In three days the work was completed, and was not better than any child could have made with the same material, wrapping, winding, and fitting them over his fist. Not one particle of ingenuity was displayed at any time. On the fourth day the first egg was laid, and on this day a cat succeeded in catching the male bird. As the female did not seem to miss him very much, and as it was this mishap that made the subsequent study of the nest and female bird possible, I did not object to the interference. The widowed wren wandered about quite as usual, constantly uttering a very cheery chirp, and gathering up a goodly quantity of insects every day. One egg was laid each day, until four had been deposited, when she commenced sitting. The fourth egg was pure white, the others of the usual color and markings. An interesting physiological question here arises which may be briefly referred to. This species of wren usually lays from seven to nine eggs, and hatches them all. Did, in this case of the widowed wren, the influence of the male only reach to the third or possibly the fourth egg? Of the four eggs laid, the last did not hatch, and I judged from its contents that the yolk had been imperfect. Again, did the death of the male bird indirectly cause the shell of the fourth egg laid to be wholly colorless? The season was too far advanced to make any additional observations, and I may add furthermore that this is the only instance I ever knew of a bird continuing to sit after the death of her mate.

After the young wrens were but a day old, the parent bird was seldom seen except for a moment at a time, when she would dart into the outbuilding through a knothole in one of the weather-boards, with a supply of food for her young. Then off she would go again, usually to the low roof of an adjoining building, and there would chirp most shrilly if any one happened to be near, fluttering the while in a most distressed manner, as though determined to make those who might be passing believe that she had a nest up on the roof, or anywhere, except in the spot where it really was. This habit was so marked as to attract the attention of the members of my family; and, if the out-building—a work-shop which was continually visited during the day—happened to have any person in it when she arrived with food for her young, she would dart back as rapidly as she came in, and go through her accustomed antics on an adjoining building, while still retaining the food. By the middle of August, the young, although but scantily feathered, had left the nest, and in a day or two, old and young departed from the neighborhood.

The song of the Bewick's wren is very fine and more melodious than that of the common house-wren. There is not in it, however, or in any of the various utterances of the female, any trace of mimicry or ventriloquism, and when I saw the anxious wren labor with both voice and body, and with all her might, to make her supposed enemies believe her painfully acted and harshly uttered lie, I could not but recall the advantage of the chat, in being able to remain comfortably at home, and send his voice on an errand, whenever and wherever it seemed necessary.

With reference to this wren's nest, it may be said that this species usually builds a very commodious and neat structure in a concealed spot, and not, as in this case, on the top of a window-frame, in full view, like a peewee's. It was really an instance of what is often seen in nest-building, carelessness and laziness on the part of the builders. In my studies of birds' nests, I have found exposed positions chosen, because the twigs and branches grew in such a manner as to lessen the labor of building. Thus we see that, while some birds are "smart," others are less so, and that not a few have their weaknesses, just as is so often the case in man. All of which, I think, is a strong argument in favor of the theory that the mental powers of birds are identical with those of man, differing only in degree.

CHAPTER XVII.

THE CAROLINA WREN: A YEAR OF ITS LIFE.

Early in the morning of September 1, 1882, as I was passing near the stable, my attention was called to the shrill notes of an excited little bird that, darting from the building, alighted on the fence near by and screamed *Jimmée, Jimmée, Jimmée*, so loudly, that every James in the township should have hastened thither. No response came, and again the call, a clear, penetrating whistle, was repeated. This continued at brief intervals for two or three minutes, and then, as quickly as it came, the bird flew back to the stable, entering through a knot-hole in a weather-board with such rapidity of movement that I could but marvel at its dexterity.

Half an hour later I saw this same bird again, coming from the stable through the same knot-hole, and this time it sang as loudly, impatiently, and frequently as before, but the notes were different. It said, or seemed to say, *tsau-ré-ta, tsau-ré-ta, tsau-ré-ta.* Had I not seen the bird I should have recognized it by a peculiarity in its song, which was never wanting, whatever might be the particular notes it uttered. My attention being called to this little bird—the Carolina wren (or mocking wren of authors)—I determined forthwith to study its habits as opportunity presented, for the little that I found recorded of it is far from satisfactory.

What might be the attraction in the stable was my first object to determine, for I did not suppose it had a nest so late in the season, and I had not noticed the bird particularly during the summer months, although I knew they were in the neighborhood. A protracted search failed, indeed, in finding any nest; but while I was wandering about I was surprised to see the wren enter the building and proceed immediately to search for spiders, which hitherto were abundant in every nook and corner, but now were comparatively scarce. Once the bird alighted upon the back of a horse standing in its stall, and while there quietly preened its feathers, as much as a wren ever deigns to do this, and then, with a shrill chirp that startled the animal, away it flew in search of more spiders.

Late in the afternoon of the same day I again saw the wren enter the stable and pass directly through the mow-hole to the hay-loft overhead. I followed and found that the bird had taken possession of a barn-swallow's nest, and here it was keeping bachelor's hall. The nest was placed against a rafter, near the peak of the roof, and was quite inaccessible to cats. This probably the wren did not consider. It is a sly cat that ever catches a wren napping. The bird did not like my discovering his hiding-place, or at least was annoyed by my inquisitiveness. It circled about me several times, snapping its beak I thought, and chirped an unusually emphatic *tsip*, which I took to be the wrennish for " damn."

All through the mellow September days, early and late, the clear notes of this wren were to be heard, and through October, and long after every summer songster had departed, I heard them daily and many times a day.

During the autumn there was little to note with regard to the bird's habits. The insects in the stable and outbuildings afforded it a sufficient food supply, but during exceptionally warm and sunny days it made frequent visits to a wooded slope near by, and there, among the giant oaks and chestnuts, it seemed more lively and full of song than when nearer home.

A few words with reference to the character of its song. Every utterance is sharply defined by a peculiarity that belongs only to this bird. I think I should know the bird by its voice wherever I might hear it.

Again, while the bird has a great variety of notes, I believe I have never heard it mingle these various utterances. It may chance to whistle *jimmée* or *tsau-ré-ta* or *phoé-do*, but it never follows one with the other. It is in all cases a repetition of the notes it first utters. Thus I once recorded its song as uttered during ten minutes. Its notes then were *phoédo*, *phoé-do*, *phoé-do phée!* with a rest of some five to ten seconds—then repeated; and this continued without any variation until the notes as here given had been uttered sixty-four times. As the bird was about commencing the sixty-fifth repetition it was frightened and flew off. A half hour later the bird took up its position on a hop-vine pole and sang the notes represented by the syllables *tsau-ré-ta* forty-seven times, with intervals of about five seconds between each utterance.

I find it very generally stated that this wren is a "mocker," imitating many of our common songsters. Evidences of this have never come under my notice. Carefully as I have listened to this wren for a year, I have never heard a note that I should consider as not its own, and not borrowed. It is not safe, however, to conclude that it does not mimic other birds, because the one I have studied failed to do so. One's observations must cover a wider range of territory, and extend over many years, before it is safe to be positive in the matter of the habits of birds. Only recently I read a most painful account of the many dangers to which birds nesting in the valley of the Hudson River are exposed. According to the writer but very few broods are successfully reared. Happily, here in the Delaware Valley the birds are more fortunate, and a failure is the exception, not the rule. So, too, it may be with the songs of birds. My Carolina wrens do not mimic, but perhaps my neighbor's do.

At the onset of winter, which in 1882 was late in November, the wren seemed unusually active, and sang even more frequently than during the sunny days of early autumn. At this time the characteristic tyrannical temper of the wren tribe showed itself. My wren had pre-empted the immediate vicinity of the stable, barn, and other out-buildings, and woe betide any trespasser; snow-birds, sparrows, titmice, and even blue-jays were promptly warned off by the little tyrant. If they questioned his authority it was only to their sorrow. So it proved the long winter through. No other birds came near to stay. Spider-hunting, fighting, and singing occupied all its moments, and, I am told, it was often heard to whistle late in the night. Probably it was dreaming, which is not to be wondered at, considering the activity of the bird's brain when awake.

Thus for six months this bird lived quite alone. It certainly never wandered far at any one time. It was seen at too short intervals for this. But if lonely it was not morose, and to all appearance throve admirably from September to March.

From March to September it lived another life. As early as the 7th it appeared upon the scene with a companion. The two were very noisy and demonstrative. I could not detect much evidence of affection, and at times their actions were strongly suggestive of quarreling.

This, however, did not last long. In the course of a week they had settled all their little differences, and hunted the spiders in the out-buildings, and early insects everywhere, in company. The song of the male bird was now more varied and frequent, yet never with a trace of mimicry of the notes of other birds. Its song in volume exceeded even the clear whistle of the cardinal grosbeak, and could be heard distinctly for half a mile during a still morning.

March 18th was a pleasant, spring-like day, and an early Maryland yellow-throat was singing merrily. This drew me out of doors, and I noticed directly that the Carolina wrens had commenced nest-building. Both birds were busy carrying long grass, strips of inner bark of shrubs, and an odd thread or two that were found near by. One bird examined the clothes-line carefully, but could not succeed in unraveling any portion.

Following the wrens, I found they had located on the upper surface of one of the plates of the frame of the barn. The nest was directly under the roof, and quite filled the space between the upper surface of the plate and the shingles, about six inches. The nest, when completed except the lining, was quite a foot in length. It was, in fact, a mere shapeless mass of loose material. Into this the female wren burrowed and remained most of the time, while the male bird brought softer fibers and chicken feathers. With these the cavity was lined and the nest completed.

March 24th an egg was laid, and another each day until the 29th, when the hen commenced sitting. During the days that followed, the male bird was very active in supplying his mate with food, and took his turn in caring for the eggs, but evidently under protest; this I conclude from the super-merry songs he uttered on being relieved. Indeed it is a marvel to me that even a female wren can sit still. They have such nervous temperaments that an entire change of nidification, whereby solar heat could be depended upon, would, no doubt, be hailed by them with joy.

Five young birds were hatched April 9th. When twenty days old they were able to fly, and had left the nest and apparently their parents. I saw them, evidently shifting for themselves, two days later, when they disappeared. May 14th the old birds were again building a nest, this time in another building, but in a similar position. The structure was identical in shape and size, but differed in being largely lined with snake-skins. It was completed by May 20th, and a week later seven eggs had been laid, and June 7th six eggs were hatched. The young were on the wing July 1st. July 15th a third nest was found nearly completed. Five eggs were laid by the 23d, and on August 8th the young birds of the third brood had appeared. These could fly by the 26th of the month, and had left the nest and the neighborhood by the 30th.

It is now a few days more than a year since my attention was particularly called to the single Carolina wren that frequented the stable. During the past twelve months it was closely watched, and every habit noted. When I was absent others observed it for me, and nothing of importance escaped attention. While I am writing these concluding lines, I can hear the bird singing merrily as it sits upon the top of the hop-vine pole, of late its favorite perch. While listening to its song it is a proper time to sum up the results of what I have seen and heard. As a songster it ranks very high and its utterances are all original. As a spider-hunter it is as active as any of the family of wrens. As a courageous foe of the English sparrows it is a blessing to the community.

CHAPTER XVIII.

DO SWALLOWS HIBERNATE?

In the year 1750, Peter Kalm, the Swedish naturalist, made the following entry in his journal, during a brief sojourn in Southern New Jersey: "I observed the barn-swallows for the first time on the 10th of April [new style]; the next day in the morning, I saw great numbers of them sitting on posts and planks, and they were as wet as if they had been just come out of the sea." On a subsequent page, he remarks: "The people differed here in their opinions about the abode of swallows in winter; most of the Swedes thought that they lay at the bottom of the sea; some, with the English and the French in Canada, thought that they migrate to the southward in autumn, and return in spring. I have likewise been credibly informed in Albany that they have been found sleeping in deep holes and clefts of rocks during winter." Furthermore, it is well to say that John Reinhold Forster, the accomplished translator of Kalm's travels, adds, in a foot-note, a series of well-attested instances of swallows having been found hibernating in the mud at the bottoms of lakes: among these instances he mentions Dr. Wallerius, a celebrated Swedish chemist, who affirmed that he had "seen more than once, swallows assembling on a reed, till they were all immersed and went to the bottom; this being preceded by a dirge of a quarter of an hour's length." Commenting upon the above and like instances, Mr. Forster is led to conclude that in countries as cold as Sweden "swallows immerse in the sea, in lakes and rivers, and remain in a torpid state, under ice, during winter;" and that some English swallows, and some in Germany, "retire into clefts and holes in rocks," while in Spain, Italy, and France, that they are strictly migratory birds.

That our American swallows are strictly migratory birds, I have no doubt; and it would never have occurred to me to consider the subject of their hibernation other than a mere fancy, had not an excellent American ornithologist stated recently that this alleged submarine hibernation was physically and physiologically feasible. This assertion is too hasty, and is not warranted by known laws of life. Having been made, however, and a semi-assent to the alleged habit of hibernation being thus given by an authority in ornithological science, it behooves the naturalist to determine how great an amount of truth there is in the statements, so frequently and forcibly made, of the persons claiming to have witnessed actions on the part of swallows, indicative of hibernation commenced, and of the discovery of swallows in conditions indicative of hibernation in progress.

Believing this supposed habit to be really a misconception of movements on the part of swallows, to be likened in some measure to the rolling habit of the mythical hoop-snake, I have taken every available opportunity, since 1878, to observe the movements of the several species of swallows that frequent my neighborhood, with the hope of determining what habits obtained among them that might possibly have given rise to the world-wide impression that swallows not only hibernate but even deliberately bury themselves in mud at the bottoms of lakes and rivers.

The species of swallow that I have had opportunity of carefully studying for the past three years are the bank-swallow, the cliff-swallow, the barn-swallow, and lastly the swallow-like swift, universally known as the chimney-swallow.

I do not propose to give here an extended account of the habits of these four species of well-known birds, but to relate the occurrences that I have witnessed, which seemed to bear upon the question. These birds I will treat of in the order named.

Probably the most abundant of all our swallows is that known as the bank-swallow, a name derived from the habit of building its nest in the steep faces of earth-banks, when they are of such composition or structure that these birds can safely burrow into them to a depth of several feet. I say "safely," for if the earth be too yielding, and the sides liable to crumble, then the bank will be abandoned. In every instance that has come under my notice the chosen banks or escarpments occupied by a colony of bank-swallows had a southern exposure, and directly fronting it, and never so far distant as to be out of sight, there was either a pond, a creek, or the river itself. Now this association of water and the colonies of bank-swallows is important.

Least susceptible to changes of weather, and dependent upon food more than temperature, the bank-swallow is the earliest of the family to appear in spring, and the last to disappear late in autumn. The alleged hibernation is a habit that concerns us only at such times of the year—in early spring, when they leave their muddy couches after prolonged slumber, and in autumn when they seek these submarine retreats.

Like all, or nearly all, migratory birds, the bank-swallows return in early spring to their haunts of the preceding summer. When I have first noted their return, often as early as the 15th of March, they were either flying to and fro over the water in front of the site of their nests of last year, or flying in and out of the old burrows, inspecting their condition, but not preparing for the coming duties of incubation. Thus early in the spring, their flight is not as continued as it is a month later. Apparently they have not recovered from the fatigue of their migratorial journey, and they rest in small companies, not upon trees, but, I may say, exclusively either at the openings of the subterranean nests, or upon sticks, dead trees, and vegetation projecting from the water. Now add the very important fact that the amount of food to be found by these swallows, thus early in the season, is very limited—being confined to a few hardy insects that are then astir if the sun is shining—and it becomes evident that, from an insufficient supply of food, their vigorous flight power of midsummer will be visibly affected.

Add to this the depressing influences of cold rainstorms, which they do not endeavor to avoid, and we have causes sufficient to explain the well-attested fact that these swallows are at this time of the year often to be seen, as Kalm described those he saw in 1750, "as wet as if they had been just come out of the sea."

Let me now mention the details of an incident of this kind. On the 17th of March, 1878, the weather for a week previously having been fairly pleasant for the time of year, a few swallows were seen; it rained very hard until about noon, when it cleared suddenly, the wind shifting to the northwest. I started out for a short ramble in search of Indian relics, and, passing by the bluff that for years had been frequented by bank-swallows, I was attracted by the incessant but feeble twitterings of numbers of these birds; none were to be seen. I looked for them for some time, and finally found a hundred or more sitting upon the top rail of a section of half-submerged fence in the marshy meadow facing the cliff. Approaching as near as I could, I found them unable, or, at least, indisposed to fly; and finally, getting to them, found them thoroughly soaked, and readily taken by the hand. Those that endeavored to escape fell into the water, and were lost in the dead bulrushes that projected above its surface. I presume that many were drowned. My explanation of the occurrence is this: they were insect hunting when the storm commenced, and, taking refuge upon the fence, they were awaiting the slow process of drying of feathers, by exposure to the wind and the fitful sunshine. This accomplished they would have been themselves again. On the other hand, had I not seen these swallows previously, there was every reason to lead me to suppose that they had suddenly appeared from some near-at-hand hiding-place, where they had been quietly at rest during the winter just closed; and had any one following in my footsteps found the poor struggling birds that I had caused to fall into the water, then natural, indeed, would it have been to suppose that from the water itself had emerged these chilled and helpless birds at the first breath of spring!

Now, on the 19th of March, 1880, there was a cold storm, with both snow and rain. Two days previously I had seen two bank-swallows. Thinking that others might be about, and desirious of seeing them during a rain, I went to the cliff near my house, but saw nothing of them. Lingering about the place for some time, I finally saw three emerge from holes in the cliff, and, after fluttering about a short time (the rain had then stopped), they alighted on a stake projecting from the water, where they remained fully ten minutes. The rain commencing again to fall, one flew away, and went, I think, to the cliff; the others flew to the same fence, where I had seen scores of them two years before, and sat near together facing the wind, just as pigeons will arrange themselves on the peak of the roof of a barn during a rain-storm in summer.

In this case, these two swallows certainly became thoroughly wetted, and had they been found later, when the storm was over, would doubtless have presented the appearance of being "as wet as if they had been just come out of the sea."

How easy it is to be misled by appearances in this matter of studying bird-life! Had I not known that swallows had been flying for days before I found these wet, bedraggled, storm-beaten birds, I could fairly have claimed that my own experience fully confirmed the opinions of others, that swallows not only migrate, but remain in mud-encased beds at the bottoms of our ponds, creeks, and rivers; but until swallows are first heard singing their farewell dirge, as Dr. Wallerius describes, then seen to sink into the mud, and are then promptly resurrected, before a cloud of witnesses, it will be safe to assert that what many have seen is susceptible of another explanation than voluntary submergence in the mud of our water-courses. Furthermore, it can be safely asserted, I think, that bank-swallows return year after year to their haunts of previous summers. A New York, or Connecticut, or Massachusetts colony of these birds, will not reach its haunt of last summer as early as will the New Jersey colonies reach theirs.

Although the recent observations of Mr. Scott at Princeton, New Jersey, conclusively show that migration customarily takes place at any night when it is moonlight, it does not necessarily show that migration at night is the common habit of all birds that migrate. Indeed, it is impossible to believe that, however brilliant the moonlight may be, any bird could distinguish, at the elevation of a mile or more, the limited area of its former summer haunts, the particular thicket in which it nested the foregoing summer; or, in the case of swallows, the little bluff wherein a colony had had their subterranean summer homes. The most that can be claimed is their recognition of the particular river valley wherein they have been accustomed to spend the summer. Granting this, if they migrated at night, then it is early in the morning after their arrival that we should expect to see them resting in scattered numbers after their journey; and when thus wearied from a protracted flight, and damped with the dews that have bathed surrounding Nature, they might well present the appearance of having arisen from the waters beneath, rather than fallen from the clouds above.

Continuing our consideration of these bank-swallows, let us now pass to the time of their annual disappearance, late in autumn, or at the onset of winter. Two conditions cause the change of habitation, or, at least, the disappearance from their summer haunts—a much lower temperature, and absence of insects, their only food. Now, severe frosts often occur in October, or they may be delayed until November, but this alone does not decide the movements of the swallows; for often they have wholly disappeared before October, and then a year may pass, with flitting swallows skimming o'er the lea, undaunted by the chill November fogs. The supposed regularity of their comings and goings is not applicable to their New Jersey haunts, however it may be in more northern localities.

What, therefore, I have seen of their movements in autumn that has possible bearing upon alleged hibernation is, first, the effect of age. Now, it is as evident as that birds grow old, that, in due course of time, these migratory swallows will reach that condition of decrepitude when they can make their migratory journey from South to North, or *vice versa*, for the last time. In such case, there must necessarily be a large number that are left behind, when the main body depart each year, unless it can be shown that these aged birds die in the course of the summer at the North, or during their winter sojourn in the South. Both statements are true. The result of a summer's study of a colony of bank-swallows revealed the fact that a number of old unpaired swallows flitted feebly about the bluff, but never appeared to wander far from it. They were often seen sitting at the openings of the nests in the cliff, and were taken for young birds. They were not fed by old birds having young to look after, and fared scantily on such insects as they caught by their own exertions. Early in August I found many lying dead, both in the burrowings and at the foot of the cliff. Examination proved that they all were old birds. In autumn, about October 1st, the main body of the colony largely frequent the weedy marshes, and seem to be forever on the wing, insect-catching, as they move in an endless labyrinth of curves over the quiet waters. I have seen thousands of them thus engaged, far from their nesting haunts. Occasionally they would alight upon tall reeds and objects projecting above the water, and twitter without ceasing. Then, as by a signal, these thousands would rise together from their resting places, and mounting to an unusal elevation fly away, to return no more that season.

These birds were associated colonies on their southern migration; but there were still left a few of those who had here spent a joyous, gleesome summer. The lame, the weak, the blind, and the unburied dead of that avian city still remained; and what a mournful spectacle they offered! painfully so in themselves, and the more impressive when the thoughtless, glittering throng of a few days past was vividly recalled.

Cheered for the time by the mellow sunlight that beamed upon them, the aged, half-helpless swallows, whose wings still responded to the will languidly, chased the few remaining insects flitting over the weedy waters. Others, venturing less far, caught, with what skill they could command, the chilled and drooping flies that sought refuge from the cold winds in these safe, snug harbors in the cliff. Indeed, this shelter-seeking flight of insect-life, that now teems about these deserted nests of the departed swallows, proves a veritable godsend to those poor birds that, from whatsoever cause, are fated to remain, if it be a blessing to prolong a joyless existence during a few brief weeks in autumn. But the importance of this sad phase of swallow-life as bearing upon our subject remains to be stated. Notwithstanding their weakness, the desire or instinct to migrate still remains, and when pressed more than usual by sudden accession of cold, or by scarcity of food, numbers of those that remain will collect as of yore, on the rushes and reeds about the water, and often commence their protracted flight toward their winter haunts. Many straggling swallows doubtless wander miles before finally succumbing to the weakness of age, though they never wander far from water, but migrate in their accustomed course, which is always coastwise, down a river valley. When their course is finished they are found in the track of the hardy multitude that have passed successfully onward. Here, yielding to the severity of the increasing cold, they find watery graves beneath the nodding plumes of the russet grasses over which, in days gone by, they had flitted without fatigue, thoughtless of the morrow.

Such swallows I have seen, year after year, and it was to them that Dr. Wallerius referred when he said that they assembled on a reed "till they were all immersed, and went to the bottom; this being preceded by a dirge of a quarter of an hour's length."

Intelligible, therefore, as I consider the movements of swallows to be, in so far as these might give the impression of hibernation beneath the water, it is not by the same observations that I have here recorded that the asserted finding of torpid swallows during the winter, encased in mud, can be explained.

The mere finding of swallows in the mud is of itself nothing strange, although the chances of their escaping the attacks of the turtles and carnivorous fishes is very small; but to find them alive, in such positions, is a different matter, and at once recalls the probability of the assertion that I have questioned, that it is physically and physiologically feasible for swallows to lie dormant under water. If so, some great constitutional change must take place, for swallows, throughout the summer, are readily drowned, if held for even a minute under water; and, if their plumage is well soaked by repeated immersions, they are helpless until thoroughly dry again. The structure of their feathers, furthermore, is wholly unlike that of aquatic birds, and therefore they can not resist the pervading action of the water, as do the oily, close-set feathers of the ducks and divers.

Again, if torpid swallows are encased in mud, beneath a considerable depth of water, by what means can the reviving influences of returning spring reach them? Whether in mid-winter or in genial April days, the mud at the bottoms of our ponds is of nearly uniform temperature, and certainly does not vary so much as to start, by its added warmth, the life-pulses of swallows that for five or six long months have ceased to beat; and why should these unfortunates remain thus beneath chilled and often ice-locked waters, when, in the mellow sunshine above, other and wiser swallows of their kind flit and twitter as of yore, having happily chosen migration rather than submergence?

But the testimony on this point is too explicit to warrant the belief that these witnesses could have been in error. To show how readily people can be mistaken, let me state a case:

A. B. has testified on oath as follows: "Early in April, 1836, as I was passing on foot down the Bordentown road, near the drawbridge, I heard a loud hissing in the bushes at my left, and, turning my head, saw a large, checkered, black and white snake. It held its head well up, and darted its tongue at me. I was a good deal frightened and turned and ran, as I had heard of hoop-snakes, and found I was chased by this snake and that it was one. Luckily, I was running down hill, and covered the ground pretty lively. Near the bridge, I jumped behind a cedar-tree, and the snake passed me. It had its tail in its mouth, and rolled along like a child's hoop, only a great deal faster. It turned off at the creek, and rolled into Crosswicks Creek, and then uncoiled, and swam like any other snake."

Now, in this statement, made in good faith by a conscientious man, there is a curious admixture of truth and misconception. Mr. A. B. admits that he has heard of hoop-snakes, and, as they are reputed to be more deadly than veritable rattle-snakes or copper-heads, it is very natural that he should see, or simply think he sees, a snake take its tail in its mouth and roll, hoop-like, down the sandy road. This impression is always the more vivid when the snake happens to take the same direction in which the poor frightened person may happen to flee. Now, if people are taught to expect to encounter any given form of dangerous animal, in any neighborhood, they are apt, when any creature having the similitude of this mythical foe to humanity is seen, to endow it with all direful attributes, and their distorted vision will convert into a horrible monstrosity, and detect impossible capers in a harmless and inoffensive creature.

Now, I have taken the trouble to question a certain class of people concerning this hoop-snake, and I find it is firmly believed in by hundreds, who affirm that they, their parents, or some one of their friends had seen them, been chased by them, or had indirectly captured them, by suddenly darting behind a tree, when the snake would uncoil, and, striking its tail into the tree, would be held by it, and when in this position would be killed by the person pursued.

Now, all of these statements are just as explicit as the finding of dormant swallows in the mud ; yet, one and all, they are absolutely false. If, therefore, the impression is made on the minds of the young people of any community that swallows hibernate in the mud, it will be difficult to rid them of the idea that any swallow that may be found in, or even near water, is not indicative of the truth that swallows do really pass the winter in such a manner. Is this more unreasonable than that the belief in hoop-snakes should be so common, even among otherwise well-informed people? If we can not explain this impression that swallows hibernate in mud, and beneath water too, in some such manner as I have endeavored to make plain, then our only alternative is to exclaim, in despair, "Lord! Lord! How this world is given to lying."

Let us turn now to a less abundant, but no less interesting species, the cliff-swallow. This bird, instead of burrowing into a bank, builds an elaborate nest of mud under the eaves of barns, along rocky ledges, and, in New Jersey more frequently than elsewhere, on the beams supporting the floors of bridges. Proximity to the water is desirable evidently, but is not an essential condition of the locality chosen for their nests. As in the case of the bank-swallow, these birds also live in large communities, and present much the same general features of swallow-life.

The peculiarity of their nest, in being made of mud, of course necessitates frequent visits to water, whence they derive this material for their nests. Now, unlike the bank-swallow, the cliff-swallow is a late arrival, and no sooner here, tired as he must be, than he commences the work of building a new nest or of repairing the old one. In either case it is absolutely necessary that he should dabble in the mud. Day in and day out, for a week or more, his whole time seems spent in mixing mortar by the water's side, and transporting it in little bits to the nest. He is wet and bedraggled much of the time; and if a cold northeasterly rain sets in, as is so often the case during the first week in May, then these swallows are in a sorry plight indeed, and, suspending building operations, they huddle about in numbers, twittering mournfully, on the principle that misery loves company. Such storms even sometimes prove fatal to many of them, and they are more frequently found dead near their nests than are individuals of any other species. Find them, then, during a storm, or even notice them, for the first time, when they are sitting on the ground near the water, dripping wet at times, and the impression you will have will be that of Kalm, that they look "as if they had been just come out of the sea." This impression, too, is increased from the fact that there are no heralds of the northward-moving mass of swallows of this kind. One and all, they come together. Yesterday, not one was to be seen; to-day, the entire community are settled in their old haunts, and ready for housekeeping. Their migrations are continued through the night, and either by starlight or moonlight, as the case may be, they are guided to their several haunts of the preceding summer.

I am very positive that they arrive during the night, and I lay unusual emphasis on this fact because the appearance of such a flight of swallows the morning following their arrival would be apt to give an impression of aquatic hibernation, if such an idea had ever been expressed in your hearing. Not the entire colony will immediately seek the nests of the past summer, for there will be many young birds who have as yet not built nests, and there will also be birds yet to choose their mates. Now, such birds will sit in long rows on telegraph wires, on fences, and, if the water be near, be very sure that they will congregate about it. Thus congregated about a pond early in the morning, perhaps after a heavy dew, and you can readily see that they will be "as wet as if they had been just come out of the sea!"

In the reference made by Kalm to swallows, he specifies the barn-swallow as being that which he saw on the 10th of April (new style), 1750, in a wet, spiritless condition, sitting on posts and planks. Now, in this case, we have a species of swallow that differs greatly in its habits from the preceding. While sociable, and willing that a neighbor should dwell near by, they are by no means gregarious; and it is often observed that but a single nest will be in a building, however large it may be. Unlike the bank- or cliff-swallows, they are quite contented to seek their food flitting over fields and about the buildings wherein are placed their nests. They are not to be associated with water or its vicinity, any more than with the driest stretches of dusty fields.

How, then, are we to explain the soaked appearance of those seen by Kalm, sitting on posts and planks? I think the preceding sentence explains it. He saw these birds first on the 10th of April, and on the next day far greater numbers of them, sitting on posts and planks. They had but reached their destination—probably had just completed a protracted flight of hundreds of miles—and were seen early in the morning. Thoroughly fagged at the end of a long journey, and early in the day, when all else was dripping with the moisture of rain-like dew, would it not be strange indeed if these new-comers, like all animate and inanimate nature about them, were not "as wet as if they had been just come out of the sea"?

But the barn-swallow asks no lengthy holiday on his arrival. He quickly recuperates, and the duties of the hour are squarely met. If, during the summer, his wanderings are less about water than land, it is to the water that he goes first, when ready to construct his nest or repair the structure of last summer. By the water's edge, he carefully mixes the adhering mud that forms the exterior of his house. Here, we have a repetition of what I mentioned with reference to the cliff-swallows. Just at the time when the supposed mud-encased swallow should leave his submarine abode, and all bedraggled, wet and worn should be seen spreading himself in the sun, and drying out, in readiness for a summer's campaign—then do we really find the beautiful barn-swallows busy at the water's edge, and often well wet through; but, instead of having lately emerged from the water, they have literally dropped from the clouds.

But if, for many and good reasons, we set aside, as a misconception of the facts, the impression still retained by many, that swallows hibernate in the mud, at the bottoms of lakes and rivers, what have we to say of the more reasonable proposition that they hibernate, as do many animals, in underground retreats, in clefts of the rocks and even in hollow trees? Now, the one simple way to decide this matter is, to find them hibernating, as they are said to do.

So far as my own experience extends, I have never found a swallow hibernating in any position, nor do I ever expect to; and, furthermore, I believe nine tenths of all the accounts that are published of the discovery of the hibernating swallows could be readily explained as something very different, if all the facts of the case could be ascertained. But when we come to study very closely the habits of a familiar bird, that to all but ornithologists is a veritable swallow, our common swift or "chimney-swallow," then I am fairly staggered, and find myself saying beneath my breath, "After all ——!"

In conclusion, then, it behooves me to consider this common chimney-swallow very carefully and candidly, and determine how far certain occurrences that I have witessed are indicative of hibernation.

In a large unused chimney of an old house built in 1708, standing near my home, thousands of chimney-swallows annually congregate, arriving in April — or appearing then—and departing, well! I am not certain when.

Now, this chimney has an internal surface of about four hundred and twenty-five square feet, and, allowing one square foot to each nest, will accommodate so many pairs of swallows. But I find that not more than one third of the available space is utilized. At this rate, there would be one hundred and forty pairs of swallows occupying the chimney at one time. Now, this may seem like a fish story, but it is an inconsiderable fraction of the truth. I have carefully timed by my watch an unbroken line of entering and out-going swallows, and seen them in these processions steadily enter and reappear for five and a half minutes, without a break, each bird followed by another so closely that intervening spaces were scarcely discernible. The downward and upward series were of course different birds to a certain extent, and it is a fair estimate to say that fully one thousand swallows were making a nesting and roosting place of this one chimney at the one time.

Not the least curious feature of these large colonies is the evident fact that but a small proportion of these birds are nesting at this time; and we are lost in amazement when considering that the fragile eggs and tender fledglings should escape destruction, surrounded as they are by such a crowd of jostling, climbing, crawling, tireless swallows. Nor is it at all easy to reach any definite conclusion concerning the object of these non-nesting birds, in thus continuously through the day entering their roosting place—the chimney.

Now, these particulars are mentioned in this connection to show that many hundreds of these birds often roost in the one place, and must be very closely packed together when all are at home. For a portion of every twenty-four hours they are well able to withstand the depressing influences of a crowded condition, with certainly a minimum of fresh air to breathe. The same conditions would prove fatal to most other birds, if indeed not to all others.

This feature of the summer life of these birds please bear in mind.

Any time after the middle of September there is likely to be a change. A severe northeast storm coming, they are gone! A week may pass, and not a swallow is to be seen. You may listen at the chimney holes, and not a swallow is to be heard. The sky is as birdless as in bleak December. But again the weather becomes warm; our magnificent October days are come. The mellowest sunshine of all the year gilds the broad meadows and adds a glory to the scarlet maples; and again scores of chimney-swallows, as before, are flitting all day long in the cloudless skies. Whence come these birds? They are not so many, indeed, as were here before the biting northeast winds bade all our summer birds depart; but far too many to consider them as mere stragglers. Indeed, they are too strong of wing to be thus looked upon. We felt, or might have felt, certain that the swallows had gone; but with the returning cheery days these birds are again with us. Either they were closely stowed away during the storm, or they are more northern birds which, leaving their summer haunts beyond the track of the storm that visited us, had only reached us as they were moving southward after the storm had passed. This, I think, very likely is the truth of the matter; but many circumstances strongly point to the former supposition—that of temporary shelter during the storm. Here is an instance. On the 4th of October of the past year the weather with us was warm, the thermometer ranging from 65° to 85° Fahr. Throughout the morning there was a brisk shower, or series of showers; but by 2 P. M. it had cleared, with a gentle wind from the north. It gradually grew colder, and by sunrise on the 5th the temperature had fallen to 40° Fahr., and the wind had increased in violence. All this day thousands of chimney-swallows and a few of other species were seen flying southward, keeping as near to the ground as possible, just avoiding the tree-tops, and in open spaces often just clearing the ground. They were in dense flocks, and appeared to be driven helplessly before the cutting blasts of the north wind then prevailing. The weather moderated the next day, and on the 7th of the month there were very many swallows flying about just as usual; they did not finally disappear before the 20th of October.

Such flocks of swallows as I have mentioned are certainly indicative of a voluntary or forced migration to a certain extent. What becomes of such storm-driven colonies (and they are an annual occurrence) I cannot say; but they are certainly indicative of the habit of migration obtaining among these birds, to a certain extent. On the other hand, what of the many swallows that remained for fully two weeks after the storm I have mentioned? As bearing upon this point, the following is worthy of note: In December, 1879, I had occasion to have a wood-stove removed from a fireplace, and one for burning coal put in its place. The removed stove had not had a fire in it for nearly a year. On detaching the pipe, there were found seven swallows in one of the elbows, occupying the space between the angle and the damper. They were all perfectly well and comparatively vigorous. On being placed upon the floor of the room, they soon recovered their full senses, and, after a feeble flight about the room, passed quickly through an open window and were seen no more. The great bulk of the chimney-swallows apparently departed by the 25th of October of that year. I certainly saw none later; yet fifty-five days after that date seven are found, in fine health and strength, snugly stowed away in a stove-pipe. It is fair to suppose that they had lived for this length of time without food. If so, have we any right to limit the length of time that they may thus remain in a semi-torpid or hibernating condition? To maintain that such a question is reasonable is not an attempt to carry water upon both shoulders; for swallows' hibernation in sheltered places, surrounded by the atmosphere, is vastly different from lying in mud at the bottom of a lake or the ocean. In a second somewhat similar instance that has come to my knowledge, a number of these birds were found in a hollow sycamore which was cut down in the month of February. These birds were dead when I saw them, and I was assured by the wood-cutter that they were stiff and cold when he took them from the tree. They were not frozen, however, and the appearance, on dissection, was such as to lead to the belief that they had died but very recently; certainly before the tree was cut down, but not long previously. There was no decomposition; some trace of fatty tissue, and the blood liquid; the bowels and stomach empty, but moist, soft, and flexible.

In this case, happening during a remarkably mild winter, that of 1879–'80, it is possible that swallows might survive in such quarters, when a season of ordinary severity would destroy them.

It is claimed that we do not know where the winter haunts of these birds are; if so, may it not be that, like the almost as abundant bats, these birds congregate in caves or hollow trees? But if we grant this much, these hibernating places are not to be looked for in New England or the Middle States, but so far south as to be beyond the reach of the severest frosts of our winters. Certainly, did they hibernate with us, in the same manner as the bats, their hiding-places would have been discovered far oftener than even such instances as I have related have been noticed. As a thousand or more may be found in one chimney during summer, it is fair to presume that, in hibernating, equal numbers would then also be congregated. No such swallow bonanza is yet upon record. On the other hand, if chimney-swallows are thus disposed of during winter, it becomes easy to account for stragglers that, for some unknown reasons, have not joined the innumerable ranks of their fellows in their southern flight; but which, in lieu of this, have essayed to brave the winter by seeking such shelter, in protected places, as they may find. That such stragglers can survive an ordinary winter has not been shown—can not be, until they are taken in full vigor from their hiding-places at the close of the season. To find living swallows in a cave, tree, or chimney in February or March, would be a decisive matter; to find such birds before New-Year's-day does not show that they would be able to remain in health the season through, and reappear in full vigor in March or April.

Judging solely from my own scanty observations, the chimney-swallow is practically a migratory bird, so far as New Jersey is concerned. In what manner the winter is spent beyond our boundaries, I can not say, but offer such trivial instances as I have related as possibly confirmatory of the belief on the part of many, that, like bats, they strictly hibernate. It remains as yet, however, an open question; but to discover that such was really true of them would have little bearing upon such a strange belief as that true swallows hibernate in mud.

What is still needed is a system of the most careful observations, made without a trace of preconceived opinions. What child but thinks that our flying-squirrels really fly, instead of sail through the air! Too often, ignorant ourselves, we give evasive answers to our children, and many errors are thus perpetuated by the world at large, which a little patient observation might readily have checked. On the other hand, when we affect to become observers, how often do we rashly jump at conclusions based upon deceptive appearances! Certainly, in my own brief experience, I can only testify to the apparent reality of a bird, less common than swallows, but superabundant in New Jersey, hibernating in mud. I refer to the little rail, or sora. Early in August, with all the regularity of the passing seasons, these birds suddenly appear in vast numbers, in the meadows skirting the Delaware River. Now, ornithologists know well enough that the rail is strictly migratory; but I have yet to see the first gunner, or other person familiar with our meadows, who ever saw a rail-bird earlier than in July, and seldom then. Nevertheless they are here weeks prior to that month, but so closely do they keep themselves to the muddy, weed-grown marshes, that their detection is well-nigh impracticable. Of course, there must be taken into consideration the fact that, prior to the middle of August, they are not sought for; but then, and until after frost, thousands are killed by the gunners. Now, the gunners, the farmers, and those whose business or inclination takes them to these marshes, know the rail-birds as a suddenly acquired feature of the locality, and, if they see them, see them running lightly over the mud that skirts the ditches in our marshy meadows. They are as much a feature of such localities as frogs; but, unlike them, they are extremely sensitive to frost. It is not strange, perhaps, that the impression of hibernation should have been entertained with reference to this bird; but it must be borne in mind that mere sudden disappearance should not suggest hibernation in the mind of any thoughtful person. Birds that migrate by day, rather than in the night, disappear as suddenly as do the rail-birds, but, being seen on their migratorial journeys, of course are not invested with any peculiar habits.

It seems never to have occurred to those who insist upon the hibernation of the rail-bird in the mud, that a still greater mystery is the impulse that should affect all these birds at the one moment; for their sudden and simultaneous disappearance is always insisted upon. The truth is, however, that they do not disappear all together. After the first hard frost, be it early or late, the great majority of them promptly disappear; but a fraction of their former numbers remain. Now, what I believe to be a rational explanation of the apparent hibernation is this: The number of rail-birds in a given tract of marsh is suddenly greatly diminished (this occurs on the day following the first hard frost); those that remain are often weak of wing; and many are found dead, probably having been wounded by the gunners. One and all are found only in the marshes, and coupled with these facts is the one more important than all, that the rails are not seen migrating. They invariably depart at night. Herein lies the solution of the common impression—one far more prevalent than that concerning our swallows, whose movements we can watch. While we are familiar with the rail-birds, they are associated with frogs and the aquatic life of our marshes. Frost comes and they are gone. We do not see either frogs or rail-birds disappear; but we know where the frogs are, and, remembering the amphibian habits of these birds, we continue to associate them with the croaking frogs, and relegate to the mud these timid, weak-winged birds. But, in truth, they have gathered their long-husbanded strength, and, in the stillness of the frosty night, have winged their way southward without a sign.

As I pointed out in the case of the swallows, many are unable to undertake the journey. It is safe to say that thousands that are crippled by the sportsman remain in the marshes all the winter, but they finally succumb to the rigor of the season.

It would seem as if such old and crippled birds had been made the objects of careful study, and from them alone facts had been derived which have been offered and accepted as embodying the authentic life-histories of these birds.

CHAPTER XIX.

A SECLUDED CORNER.

Once, in the far distant past—perhaps so long ago that a vestige of the ancient glacier of the river valley still lingered on the distant mountains—a broad and shallow creek meandered through the meadows that skirt the river, and, after a mile or more of independent flow, was lost in the greater volume of that stream. This little creek, fed by springs that issued from the bluff that runs parallel to the river's course, pursued its winding way through a dense growth of hickory, oak, birch, and maple. Along its banks the Indian roamed, and in its quiet waters he found an abundance of fishes. There was a time, too, when the spot was beautiful, and there still remains a vestige of its former beauty; but only by careful searching can it be recognized. The springs that gave this creek its volume of waters have sought other channels; the coming of the white man proved the destruction of the forest; and now there is left only the half-dry channel, choked with rank grasses, bulrushes and reeds. This to the farmer is an eye-sore, as it yields him no profit; but to me it is indeed a pleasant place, for I find a charm in the wild growths, teeming as they are with feathered occupants. In place of the forest, there are now broad stretches of dry pasture, with here and there a single oak or hickory left to tell the story. Fortunately in one corner of this low-lying tract, called the "mucky meadow," there remains a clump of large maples, pin-oaks and birches, which have somehow been spared by the former owners of the land. They are mine now and are safe. This out-of-the-way corner is a whole library of natural history to him who knows how to read it through. I do not believe I ever can do so, but I have made some progress, and this is what I have learned.

Where the ancient creek makes an abrupt turn to the east, and where now the mucky meadow begins, stand these maples and oaks. Perhaps they are not very old, but doubtless their ancestors stood there before them; and in the hollows of those earlier trees the forefathers of the owls that are now here, lived, and hooted and screamed in the ears of the superstitious Indians, who trapped the otters and beavers that then abounded in these waters.

The mucky meadow itself has both a geological and an archæological history, full of interest; but these are subjects upon which I can not dwell at this time, my only object being to call attention to its many merits in an ornithological point of view.

It is here, at the first intimation of the coming spring, that the red-winged blackbirds congregate and fill the air with their delightful music. It is here, in mid-summer, that the swamp-sparrow loves to dwell, and vies with the marsh-wrens in enlivening the rank growth of aquatic grasses. It is here that the little soras or rail-birds congregate, and thread their way through the dense growth that mats the meadow. It is here that, in early autumn, the bob-o-links, in russet dress, swing from the tall reeds and repeat in mournful monotone their tiresome "chink"—"chink." Let us pass these by and wait until October. With the first white frost there comes a change in the foliage. If the summer has been wet (very rarely the case of late years) the leaves will turn to beautiful shades of crimson and gold; but, if there has been a drought, then they are merely browned and soon drop. In either case, it is in October, and not until then, that we fully realize the summer is past. With this change, there comes another quite as marked in the animal life. The few birds that remain change their habits materially, while the many summer sojourners seek a sunnier clime. The birds that went northward in May now return, and after tarrying a few days pass on to the south; and late in the month arctic and semi-arctic birds come among us to remain during the winter.

In our secluded corner there has come more than once a change that I am ever ready to greet with gladness. The hollow maple, that throughout the summer has securely housed a family of short-eared owls, now gives evidence of the fact by dropping the leafy screen that hid them. Although fully grown and strong upon the wing, these owls continue to haunt the tree, probably because the surrounding meadows are so wet. While not blinded by daylight, it is during the gloaming and moonlit nights that they are most active, and the number of meadow-mice they destroy is extraordinary.

Of a single owl, however, but little can be said. It is in summer, when parents and young are still together, that one should see them. Then, indeed, it becomes evident, first, that owls are great talkers; and, secondly, that they are decidedly intelligent. I was impressed with these facts during one pleasant, moonlit summer night, when, having taken my stand, I saw the whole family of six as they came from their home. The old birds first appeared, flew directly toward the meadow, and disappeared in the long grass. Soon the four young birds made their appearance, but only to creep along the limbs of the tree, and then settle themselves, in a lazy, muffled-up manner, as though nothing remained to be done. All the while the old birds kept up a peculiar call—more like a scream than a hoot—not altogether unpleasant to the ear. I am in doubt whether the young owls made any reply, though I took a faint clicking noise to be such. In a little while, however, they began to get hungry, and then they uttered unmistakable cries, to which the parent owls replied by returning to the tree. In the beak of each owl was a mouse, or what I took to be such, and when they alighted on the maple I could detect, in the uncertain light, that they did not approach closely to the young birds, but, having removed the mice, which they now held in their claws, they chattered and screamed to their young, in a manner that could only be interpreted as, "Come over here and get your mouse." It was evident that the young owls were to be taught to help themselves, and to practice their power of flight. As an inducement to do the latter, the mice were held temptingly before them but quite out of reach. Finally, one young owl, more venturesome than his fellows, essayed to fly, but it was a miserable failure, for, instead of reaching the desired branch, it fell short a foot or more, and tumbled to the ground. I can not prove that owls laugh, but I think any one who heard the old birds just then would never doubt the fact that they do. The funniest feature, however, was that the three remaining young birds were disgusted with what they saw, or were frightened by it—at all events, they hastened back to the nest, and I saw them no more that evening.

Of the poor fellow that fell to the ground there is much to be said, as it was with it that the old birds were now wholly concerned, and their actions were highly entertaining. Leaving the tree they flew down to the hapless bird, and muttered in low tones to it, in a most sympathizing manner. Their utterances now, which I could hear notwithstanding the racket made by the toads, were very varied, and gave the impression that they were holding a conversation. After the lapse of a minute or more the old birds together took a short, low flight, and then returned to the young owl. Was it not to show it how easy flight was? Then again they flew away, in the same manner, and the young owl endeavored to follow. It was with evident difficulty that it left the ground, but when once its feet were clear of the grass it progressed satisfactorily, though only for a short distance. This pleased the old birds, for one of them came to the plucky little fellow, and, with one wing extended, patted the young bird on the head and back most tenderly. At this I laughed aloud, most unfortunately, and immediately the old birds flew to the nesting-tree, and then discovered my hiding-place. Of all the scoldings I ever got, that from the owls, this evening, was the severest. As I moved away I recalled the oft-witnessed scene of the king-birds worrying crows. It was the same thing in my case. Keeping just out of reach of my cane, they swooped about my head and snapped their bills viciously. They did not dare to strike me, but they came unpleasantly near, and it was with a feeling of comfort that I finally reached safer quarters.

Another feature of this secluded corner is worthy of mention. The herons for many years have occupied it as a roost, and every spring the little green "fly-up-the-creek" has nested in the maples here. Their nest is a slight structure of coarse twigs, and the contents consist of two dirty-green eggs, which disappear in good time, and their place is taken up by as comical a pair of dirty-tinted down-clad creatures as can be seen. When the birds are less than a week old the nest is often forsaken, and the downy, awkward birds find a resting place on some convenient branch. Apparently they are quite at home, though they do not look as if they were wholly comfortable. Their legs are not fully equal to the task of supporting the body for any length of time; and, on the other hand, the art of sitting down gracefully has not yet been acquired.

As these little green herons usually build in small colonies, sometimes four or six nests are in one tree. One summer, some few years ago, there were three nests in this tree, and when the birds were about ten days old every nest had tumbled down, and five young herons sat in a row on one of the horizontal branches. They were an odd-looking company, and, so far as the parent birds were concerned, it must have been a difficult matter to recognize their own offspring.

When young herons happen to fall to the ground, as is frequently the case, they are then beset by several enemies, two of which are of unusual interest. These are the musk-rat and the snapping-turtle. The homes of both all summer are essentially aquatic. The musk-rat does not often leave the water, and it is supposed that the snapper never does at this time of year. When, however, it happens that a young heron or two fall to the ground, the parent birds notify the neighborhood toward night-fall, and among those that quickly respond, or at least are attracted by the sounds, are the musk-rats and snappers. If either chance to find the young birds they are quickly disposed of, although the parents offer a vigorous, and at times an effectual, defense. A most interesting point is that if, as appearances indicate, the snapper was attracted by the cries of the herons, was it out of the water at the time, or has it so acute a sense of hearing that it is cognizant of occurrences above water, and at a distance of nearly two rods? I have twice seen a snapper in broad daylight seize a young heron that had fallen from the nest; and once witnessed the successful effort of the old herons to drive off a musk-rat. Possibly in the matter of the turtle it was a mere coincidence, the turtle happening to pass by as the heron fell. It may have been so, but I do not believe it; and I pin my faith on the chance saying of an old fisherman, who once said to me, "Snappers don't stick so close to the water as people think."

During the very open winter of 1879–'80, a pair of night herons or "quoks" made this tree their roosting-place. During the day they sat silent, and nearly motionless, close to the main stem of the tree, and so were inconspicuous and therefore safe. Near by, in the meadow, is a large spring, about which the grass always remains green. Here, too, a few minnows and fewer frogs remained in full vigor, and I suppose from this source their scanty food-supply was derived. During the clear, moonlight evenings of this winter, it was truly an uncanny feature of this corner to see this pair of night herons or "quoks" sally from the leafless maples, and, while flying over the meadow, to hear them cry with a harsh voice that was the more ghost-like in the still air of a mid-winter night. Perhaps the cry was answered by the cat-like scream of the long-eared owl, and, if so, the secluded corner was for the time a weird spot indeed, and one to be shunned by those unfortunates who have no taste for Nature in her wilder aspects.

How little would any one, who simply passed during the day, imagine the variety of forms of animal life that congregates in such a corner. The hollow in the large maple is not visible from the ground, and yet it is a capacious cavern, and the home of owls nearly the whole year through. In a tortuous burrow at the roots of the tree is the home of a pair of minks, that have laughed at all my traps; in a black oak near by there are opossums nearly always to be found, and in the long grass of the meadow the musk-rat has his home. A few of the birds I have already mentioned. What need, then, to travel to distant parts with such a wealth of entertaining life near by? I have been familiar with all these mammals, birds, reptiles, and fishes, from my earliest years, yet not one of them is so well known that a day's study of them, in their own homes, does not yield something new. Lingering by the hour in this secluded corner, I have heard owls utter sounds that are nowhere recorded as within the range of their cries; I have watched the wary woodcocks performing their aërial dances, if they may be so called; I have seen the fierce snapping-turtle play the gentle lover; and, when all was covered deep with winter's accumulated snows, I have tracked the musk-rat to his home; and sought out the mink, the opossum, and the skunk, in their retreats among the trees. Verily, in such a corner, one may ceaselessly turn the pages of the book of Nature, and never weary in so doing.

CHAPTER XX.

THREE BEECHES.

I HAVE often wondered that these sole remaining traces of the primeval forest did not die of chagrin when they saw how sadly changed everything was about them. However, they still stand as glorious monuments of a splendid long ago, guarding a little space of air if not of earth, wherein, unmolested, the year round, birds may congregate in safety.

These three beeches are not simply three enormous trees; but they are, collectively, my beautiful aviary. I doubt if a day passes, the year round, that at least one bird does not tarry in their branches; and it is in this aspect only that I purpose writing of them.

Let us glance at them in mid-winter. Even then, we are sure to find blue-jays screaming amid the labyrinth of leafless branches that crown the trees. Common as they are, and in spite of many unattractive ways, these birds are worthy of careful study. There is much more in them than those who know them only as "noisy gossips" would suspect. For the past three years a half-dozen or more of them have been living, from November to March, in these beeches, and have afforded me no end of amusement.

Just where they roost I am not quite sure, but I think in a haymow near by. Be this as it may, as soon as the night is spent the birds are astir, and, screaming harshly and incessantly, as is their wont, they thread their way through the innumerable branches. In so doing, they use their wings less than other birds, except the parrots. They climb from twig to twig, and walk with quite a stately mien along the stouter branches, when not too upright. Thus up and down the tree, they pick now and then a nut, but do not appear to spend much time in feeding.

Strange as it may seem, although so large, these jays are by no means conspicuous when sitting quietly on the leafless branches of a large beech. The color of the bark is not unlike that of the bird, and I am quite inclined to believe that the birds themselves are conscious of the fact. When disturbed, as by the report of a gun, I have, time after time, seen them cling as closely to a broad branch, as ever did a cunning gray squirrel when frightened. So marked is this that I am tempted to ask myself whether it was not possible that they had learned the trick from the squirrels. Bright and showy as is their plumage, these birds give evidence of knowing that under certain circumstances it does not render them conspicuous, and they act accordingly. I have noticed, too, that they will hide successfully in white oaks, during winter; but here they trust altogether to the clusters of leaves that remain on the tree throughout the season. I have seen them creep into a cluster of such leaves and remain motionless, although I was very near them at the time. In this case they evidently realized that no similarity of color existed, and that their only protection arose from cover; hence they sought it. If I am correct, it shows that the color sense is very well developed in the jays. Indeed, they have all the intelligence of their cousins, the crows; and as they are driven now from their ancient haunts in the thick woods, by the general destruction of forests, they are compelled to make good use of their wits in order to thrive in the open country. Their plumage is against them, and they know it; and their ingenuity is on the increase, it may be, to enable them to overcome the difficulties incident to their newer surroundings. During the past summer a pair of these birds built their nest in a small white oak near the house. It was constructed of dead twigs, and placed in a crotch in such a manner as to be quite inconspicuous; and the parent birds, when on the nest, so arranged themselves as readily to escape notice. They kept their heads below the level of the nest, and so disposed of their tails that not a feather was visible from below. Nor were these birds noisy during the nesting season. Indeed, it was only by chance that I found their nest, days after the young were hatched.

Unless very carefully observed, a family of jays in winter would give the impression that they were exceedingly quarrelsome. This, I think, is not true. Not that quarrels do not arise among them, for they do occur quite often, and sometimes end in the death of one of the combatants; but the greater part of their noisy vivacity and excited antics is merely the result of boisterous play. This I conclude, because I have frequently noticed that when taking protracted flights they are often as full of talk as when perched upon the topmost branch of some tall tree. They will often even turn in their flight to those far behind, and chatter long and loudly, as though chiding the laggards. In spite of their noise, it is evident that it is the chatter of excited but not necessarily angry birds.

There is yet another phase of jay life worthy of mention, and I can best introduce the subject by seriously asking, Do they ever dance? I scarcely feel justified in giving an affirmative answer; and yet some of their antics have impressed me with the idea that such might be the case. One glorious day in January, three years ago, I heard a company of these birds screaming and chattering as usual among the beeches. Although so jay-like in general, still there was a peculiarity in the multitudinous sounds that made me think that something had gone wrong among them. An owl perhaps had caught one of them. I straightway sought a convenient spot from which I might see what was going on, and I soon saw that something unusual had occurred. My first view of them showed some dozen or fifteen birds settled near each other on convenient branches, while two others occupied a broad, and nearly horizontal, branch. These latter were not sitting quietly by any means. When first seen they were standing together, but immediately separated and ran from each other as far as the branch would allow; then, turning, they half opened their wings and spread their tail-feathers much as a turkey does, and, in this manner, with head well up and crest erected, they hopped in measured leaps toward each other, giving a loud chirp at each forward movement. When they met the spectators joined in a shrill clamor of discordant cries, which continued until the two dancing jays had separated. These two birds simply met and parted. There was no further demonstration. These curious antics were repeated several times; and then suddenly, without any apparent reason, the whole company took flight.

I have witnessed such an occurrence but the once, though I never fail to think of it and look for its repetition when the jays are in the beeches. Had it occurred two months later, I should have though it an exhibition by two males who were trying to attract the notice of certain females among the spectators; but happening, as it did, in midwinter, it had all the appearance to me of a kind of amusement which is probably indulged in but seldom.

Last July I spent a memorable morning under these beeches. Something had gone wrong with the birds, and the occupants of two neighboring wren-boxes were discussing the situation. There was no quarreling, but the primp and prompt wrens were in great earnest, as their chattering and the energetic bobbing of heads and tails plainly indicated. My first impression was that the occupants of one house had trespassed upon the domains of the other, and this is a thing that no wren will tolerate for a moment. When two or more pairs of them have nests in close proximity, they parcel out the immediate surroundings, and each, when foraging, limits itself to a range that does not approach the others' houses very closely. If such a thing does occur, nine times in ten there's a row.

The wrens in the beeches that July morning, however, had a common cause to discuss, and their utterances and actions were wholly different from any sounds I had heard before, coming even from an excited wren. Had I not seen the birds, I doubt if I should have recognized their voices. After some five minutes or more of most animated discussion, a plan of action was decided upon; at least, the wrens left the beeches in company, and I was not slow to follow. They returned—as I supposed they would—to the house of one of the pairs of wrens, and settled upon its roof and upon the little perch at the entrance. When I came to the spot, I saw, at a glance, wherein the trouble lay. A pestiferous English sparrow had taken possession of the box, and "cleaned out" the wrens. The sorry interloper was at the time inside, and could not be dislodged. There was fun ahead, I foresaw, so I took up a position favorable for witnessing the *denouement.*

The wrens took their stands near by and quietly waited for the sparrow to appear. This it did not do immediately, and one of the wrens became quite uneasy. It chirped and twittered in a restless manner, and finally flew to the wren-box near by, and entered it. I suppose it was a parent-bird anxious about its eggs or young. At any rate, it did not reappear upon the scene. Some ten long minutes passed, and still no signs of the sparrow. The three wrens that remained never once quit their posts, and, wonderfully strange! they had nothing to say. Finally, the sparrow thrust his head out and took an observation. Immediately the wrens assumed a "make ready" attitude and awaited his coming.

Things looked ugly for the sparrow, and so it thought, I imagine. Still, the bird had no notion of being a prisoner, and boldly emerged from his retreat. In an instant, the three wrens darted upon the usurper and drove him from the bird-house. Vainly he endeavored to escape the sharp thrusts of their bills. The wrens were as active as swallows, and eluded every attempt on the part of the sparrow to attack them. The moment he essayed to close with one, the others were upon him, and so successfully did they manage the fight that they cut off his final effort to regain the bird-box. This the wrens had evidently foreseen might be attempted, and consequently they did not at any time leave the sparrow's way open to a retreat in that direction. Nor were the wrens satisfied with merely regaining possession of their ruined nest. They pursued the sparrow in whatever direction he took, and so wearied him with their ceaseless assaults that he finally yielded to sheer exhaustion and fell to the ground.

At this point I interfered, and, picking him up, found upon examination that he was so sorely wounded that he soon died. As to the wrens: seeing that victory had crowned their efforts, they united in singing such a song of thanksgiving as wrens never sang before.

CHAPTER XXI.

ROSE-BREASTED GROSBEAKS.

A new bird in the neighborhood is a source of joy. However common it may be elsewhere, and however familiar you may be with it "in books," yet to see it in the trees and bushes about your own home, a voluntary visitor at that, is to gaze on a novelty, and you do so with much the same feeling that you would upon a new species. Now, the rose-breasted grosbeak comes under neither head. It is not a new species, nor is it new to the neighborhood, for scores of them pass by every May, on their northward journey, and come trooping back, in October, with their families. But in 1882 they decided upon a change. They came in May as usual, and, delightful to tell, they remained—not one, nor a pair, but a great many of them. In years past, to see one was an unusual sight, and to hear it sing, a rare pleasure; but in 1882, they not only came, but seemed anxious to be seen. They perched in the trees nearest the house, and sang such songs as never bird sang before. So, at least, it seemed to all of us. Perhaps, after all, the song was no sweeter than that of the wood-thrush; but it was widely different, and was so great an addition to the orchestra, that we rated it, while new to us, as the first of the series of noble bird-songs that daily floated houseward from the woods near by.

May 21st, I spent a pleasant hour watching a grosbeak feed upon the seeds of the catalpa. The tree itself had, as yet, no foliage. From its long, naked branches, only the slender seed-vessels—"beans," we call them—dangled in the breeze, and ever and anon striking a neighboring branch, they rattled like a gourd. They had remained closed during the winter, and now, if ever, was the time for them to open and let loose the prisoned seeds. Their time, however, did not appear to have come; but to-day a grosbeak "did the business" for the one tree near my garden fence. Never was a bird more methodical in anything it undertook, and generally birds "take matters into consideration" before beginning any work. Clinging to a convenient twig, the nearest to the one that supported the pendent pod, the grosbeak nipped open the seed-vessel near the stem, making but a short incision, and then drew forth a single seed. This it trimmed, and let the light, feathery particles come floating down to me. The kernel the bird reserved to itself. Then the next seed, and the next were taken out, in the same quiet, methodical way, until the free end of the pod was reached. The last seed was detached by separating the two halves of the pod, and these then swung apart, and, slightly curling upward, trembled in the breeze, as they drooped from the dainty stem. Then the grosbeak passed to another pod or "bean," nor did he quit work until every one was rifled of its contents, split apart, and left swinging in the wind. If there were a hundred "beans" at the outset, there were now two hundred halves of bean-pods dangling in the air; giving the leafless, spider-leg branches a more ragged appearance than before. During all this time, not a note from the busy bird, not a chirp nor twitter. This was cunning, perhaps, as it might have been afraid of attracting others who would claim a share of the feast.

It was not until the settled warm weather of June that the grosbeaks began to sing much; and then, for an hour before sunset was their favorite time. Their labors of nest-building were by this time completed, and they were, I thought, rejoicing at the idea of vacation, for until the eggs were hatched there would be little to do. And such bird-music I had seldom heard before—never since. The notes had all the clearness of the oriole's, and yet were without its harshness; they were as varied as those of the wood-thrush, yet not so monotonous. The charm consisted in our not being able to anticipate the song, as it was never, I think, quite the same, though certain well-marked features were heard in every utterance, and this at once caused the bird and its song to be recognized. For weeks I tried to express the song in music, but the evening's result was a sad jumble of harsh notes, and before the summer ended I gave up in despair. At times, the wood-thrush, chat, oriole, and the vireos would join the grosbeak, and then indeed it was a service of song.

During the subsequent summer days, I found these birds usually in an apple-orchard, busy as wood-peckers, hunting for insects, even in the hottest sunshine. They thereby proved themselves to be as useful as they were beautiful. I found them, too, gathering potato-bugs, and they seemed to suffer no harm, although the vines, previous to their visit, had been dusted with Paris-green. From this I judged, as no grosbeaks were killed, that they ate only the living insects, which of course were free of the poison. This fancy for the potato-pest ought to secure entire safety to the grosbeak, so far as man is concerned; but, strangely enough, it does not, as I found a fiend collecting them, one morning, "for the milliners." Unfortunately, a defect in our laws prevented my killing the collector without getting myself into trouble, but the birds were not again disturbed.

CHAPTER XXII.

EARLY MORNING.

Before describing the spot, and our object, a word about this time of the day. The most familiar objects, at this hour—4 A. M.—have a somewhat different aspect. The country was just sufficiently the same to make us sure of where we were. Fleecy clouds enveloped the lowlands, and acres of pastures appeared like miniature lakes. The glistening dew silvered the grass along our path, and brought out in strong relief the geometric webs of the spider. Where a few hours later there will be a comparative silence, was now heard the choicest vocal efforts of all our songsters. Not a bird within hearing but joined in the chorus of welcome to the rising sun. All nature, except poor humanity, rejoiced that the glories of a new-born day were here.

My object in thus taking an early start was to have a day's shooting along the river-shore for "teeters and the like," as Uz Gaunt called the whole family of sandpipers. Plovers he knew, and spoke of them by their proper name. It so happened that early in the morning the tide would be out, and long stretches of the shore and of "Long Bar" would be bare. Uz had promised me some good sport, and soon we were on our way, he speaking of the birds we were so soon to find, as a matter of course, and I in expectation of all that he promised.

When the river was reached, for we had been passing down the Popihacka, now Watson's Creek, for some distance, a mist hung over the muddy flats and the water. Even at a comparatively short distance objects were obscured, but still we were not at a loss as to the proper direction to take, for the clear notes of several sandpipers could be heard, and these guided us.

Uz listened for several minutes to these sounds, and then quietly remarked, "The plovers are not with them, to-day, and we'll have better luck."

"Why?" I asked; for it was a decided surprise to me, to hear him say this.

"Simply because those little plovers are a great deal quicker witted than 'teeters' of any sort, big or little. I'll tell you more about them, after a bit."

Until the fog lifted, of course nothing could be done; but we had not long to wait, and soon we were able to mark the movements of troops of sandpipers running hither and thither up and down the sand. We took up our places, at points considerably apart, and approached each other, keeping a troop of teeters between us. When within twenty yards, the birds would take wing, and generally afford a shot to one or the other of us, before they had flown over the water or out of reach. In this way we bagged a score in a little while, but they soon became wild, and the shooting grew quite monotonous. In the course of two hours we were ready to quit, and before the day became really oppressive we were homeward bound. The birds that we had shot were the least sandpiper, the spotted, several "solitaries," and two of that curious form known as the "sanderling."

As we were sculling homeward, I reminded Uz of his promise concerning the plovers, and as we moved slowly up the creek he told me the following as one of his experiences:

"Some years ago, one August, there was a great flight of 'yellow-legs' and 'tell-tales,' as you call 'em, along the river. I've never, altogether, seen so many since. For a week or so, Long Bar, at low tide, would be just black with 'em. No gunners came 'round just then, and I had the thing all to myself; and it paid big. Well, early one morning, about the end of the time, I was settling myself in a sort of ambush I had, made of cedar-boughs tucked against a buttonwood log, lyin' on the bar, and I thought I heard the yellow-legs coming up the river; but instead it was a whole swad of little plovers. They settled down, black, right in front of me, and then scooted 'round, until they made me out. One or two of 'em gave a wild chirp, and away the whole of 'em went. I was glad they were gone, and takin' comfort in my luck, when the pesky things came back, but kept on the river side of my screen. They trotted up and down as unconcerned as a fly on your nose, and I paid no attention to them for a while, as I was waiting for bigger game. After a bit the big teeters I was after came within hearin', and I was all eyes for a lot of 'em to settle down within range; but what do you think? those pesky plovers set up a sort of a chatter when the big teeters came, and just made 'em keep away from anywhere near where I was. Talk about birds talking! Why, them plover told the big teeters there was danger lurkin' behind the log as plain as you or I could. The birds' actions showed that. They say 'actions speak louder than words,' and so the birds' doings told me plain enough that their twittering, when the teeters came by, was understood all 'round, and the birds acted accordingly. If you're goin' to boil it down to a lot of hard-twisted words, perhaps you can make it out that it was something different from our ways of talkin' and takin' in the situation; but to me it was one and the same, and I guess that birds' talk and ours differs just as we differ in our make-up, and not in the natur' of it. I've seen enough of birds in my time to make me believe in their talking, anyhow. Well, I got kind o' tired lyin' behind that log with nothing to do, and the tide was comin' in, and I felt like blazin' away at the plovers for spoilin' my day. If I did, I knew the others would be off, and thought perhaps they would come back and the plovers would stay. Not a bit of it. The shot laid over five or six plover and wing-tipped a teeter, and that was all the birds I got that morning. I whistled till my cheeks hurt, but it was no use; them plovers had cooked my goose for me, and I've always found 'em a cunnin' set ever since. Well, it was only a day or two after, I went again to Long Bar to see if any birds were about, but there wasn't. I was sittin' on the buttonwood when I heard a 'peet-weet' or two, and ducked down, not quite sure what it was. Betimes I was behind the log, four of these little plover was on the other side, and as busy feedin' or lookin' for food as they could be. Now, the tides had washed a little hollow in front of the log, and I'd seen in it a dozen little minnies swimmin' 'round lively and tryin' to get out. You see the tide went out too fast for 'em, and they were caught. Well, what completely took me aback, was the way these plovers acted. They wanted the minnies, and yet didn't quite know how to get 'em. They chased 'round a bit, but didn't seem to catch any, when, do you believe it, them four plovers just walked in, all abreast, and undertook to corner the little fish. Hang me, if they didn't, though. You've seen a flock of turkeys walk abreast across a field, catchin' grasshoppers? Well, these little plover just walked through that water as even along as turkeys, only they didn't keep their heads goin' all the time like the turkeys.

They just went on as a matter of course, until they had the minnies cornered, or thought they had 'em. It was a mighty funny sight, I tell you, boy, and one I only saw that once."

"If turkeys should do this, why shouldn't plovers do the same?" I asked, forgetting that he disliked interruptions.

"All I know is, it doesn't seem strange in the turkeys, and same way I've seen rock-fish move like soldiers on a school of minnies; but for the plovers to do the like seemed all out of place, somehow, just as anything is apt to when it is unexpected like. Well, to go on with my story where I left off: So far as I could tell, the fish had got ahead of the plovers by buryin' themselves in the sand. I was so took up with the way things turned out, that I raised up, forgettin' about the plovers, and went to look for them fish; the plovers put off, and I looked all 'round. There was no minnies in the water, certain, and so I dug down a bit, and, sure enough, the cunnin' things had gone down as much as an inch in the wet sand."

By this time we were at the landing, and Uz's narrative came to an abrupt conclusion, for the time being, and we were too busy fixing the boat and other matters to talk much. On our return towards home, however, over the dewy path of some hours ago, but now hot and dusty, I started the conversation by remarking that the common mud-minnow of our meadow-ditches buries itself in the mud to escape danger.

"I know it," replied Uz, "and that reminds me that I've something more to say about those plovers and minnies. Perhaps you've never watched little plovers very closely, and so don't know 'em as well as I do. Well, they have the habit of huntin' minnies that are left in puddles at low tide, as I've told you, and here let me tell you something more about this. You know wherever there is a good-sized cobble-stone on the sand, the outgoin' tide washes a little hollow on the lower side of the stone, and in this the little minnies take refuge when the water 's fallin'. The plovers know this just as well as I do, and go spookin' 'round; but seein' 'em, the minnies get clear under the stone out o' sight. How the plovers smell 'em out, I don't know, but they'll just splash and dance 'round, and somehow seem to scare 'em out, and then they gobble the littlest of 'em up. When they are too big, as is mostly the case, they only worry at 'em, for it is only the little wee bits of minnies they can make out to swallow. There's another kind of minnie, or little fish o' some sort, they don't disturb, I know, and sometimes a whole regiment of 'em will be on the flats at low tide. They are like little perch in looks, and go off with a skip and a jerk, instead of swimmin'."

"You mean what are known as 'darters,' I guess. Little fish with big spiny fins, that lie at the bottom of the river and the creek, where it is sandy," I suggested to Uz.

"That covers the whole ground, boy," he replied, and continued, "and they have been something of a puzzle to me. Last spring, when I was huntin' for my sheath-knife at low tide off Long Bar, I was lookin' at the bottom as I floated along, hopin' to see my knife. About halfway down the bar, I see the carcass of a musk-rat somebody had skinned, lyin' on the bottom, and just about a thousand of these little 'skip-jacks,' as I call 'em, were feastin' on the rat. I halted a minute, and watched 'em. They would kind o' haul off, and then give a dart at the rat's carcass, and catchin' a bit in their jaws, take it away with 'em and gobble it up when they'd got fairly settled on the sand. Then up and at it they would go again. I marked the spot, and next day was along there again. The fish had gone, but they had about made a clean skeleton of the carcass. I never before saw so many of 'em together."

"Why do you think plovers don't eat these darters as well as the common minnows?" I asked.

"Simply because, when I've been ambushed on the flats lookin' for teeters, I've seen lots of these little skip-jacks caught in the puddles. Could see 'em skippin' out of the water, and the little plovers would run right among 'em and not notice 'em. Things like that, happening right under my nose, I can't help but notice. Sometimes the plovers would chase little fish; sometimes they wouldn't; and I found the skip-jacks they let alone and the littlemost minnows they gobbled up."

"A good many people might see all this and never know what it meant," I replied, and added, "I've seen plovers often, and shot dozens of 'em, but this is all news to me."

"That's just accordin' to what I've told you more than once. If you waited until you were as old as I am before you printed anything about birds, you would then likely tell a good many things nobody would believe—like enough be set down as crazy. I've never told you half I've seen in my days, and do not mean to. You wouldn't believe some things."

"Indeed I will," I replied quickly; "I'd rather have your opinion and knowledge than that of any one I know."

"All very well to say, boy, but you'd feel a little doubtful about it if I gave you a full account of my years of lookin' at things in natur'; anyhow, I won't do it."

"I hope you will change your mind," I remarked, knowing coaxing was useless; "I want, anyhow, to hear you again about the snakes in the June freshet. Remember, I didn't see any of any account."

"Perhaps I will, some day," Uz replied, "but not now."

Here we reached the cross-roads and parted for the day.

CHAPTER XXIII.

A WALK IN WINTER.

THE whole range of field, forest, and meadow, with their scattered patches of tangled thicket and lace-work of worm-fences, on which I looked from my study-window, had during a recent January morning a marvelously altered appearance. That the familiar land-marks were all there I had no reason to doubt, but ready recognition of them was, after all, not so easy, when a deep, undrifted snow covered everything.

What though an open fire-place and hickory logs were at my disposal? These are incomparable after sundown; but it argued no want of love for my grandmother's andirons, if so early in the day I did not succumb to their charms. Let me first weary myself with a tramp over the snow, which will not last but a day or two, it may be, and gather material for a dream by the blazing hickory logs when it is gone, for the wood will keep.

Not a sight nor a sound of bird for the first half mile; and as it was a matter of wading rather than walking, much of the time, I began to feel discouraged and thought of the andirons. But when fairly in the open fields, the snow-crust was firmer, and a change came over the spirit of my day-dream. I heard a bird chirp, and at once felt my strength renewed. Nor does this indicate mania on the subject of birds. To be sure, I could have heard sparrows chirp, to my heart's content, by merely raising my study-window; but these were English sparrows, and *de gustibus non est disputandum.* I would rather raise Cain with the misguided people who brought these truculent little wretches into the country.

The bird-note that I had heard was nothing but a faint chirp, but then it did not come from a sparrow's throat, but from a prettier one and a wild one, whose owner is never here in summer. Here, then, were all things needful to play "up North," as the children say: snow, ice, cold weather, arctic birds; and so the fun began. I heard a faint chirp, and then an answering one; then a clear, ringing twitter filled the crisp air, and a great company of horned larks came flying by and settled daintily on the broad expanse of snow before me. So I had not, after all, taken a walk for nothing.

Of all possible sights of a snowy winter, whether in the open fields or the hoary forests, that of a company of tripping, chirping, merry horned larks is the most beautiful. Nor do I wonder that they like so well to be abroad at such a time. Can sunshine be more magnificent than when it gilds acres of untrodden snow? The larks, at such a time, need little shelter from pursuing foes. The merest ripple in the surface grants them all they need, and sharp eyes are required to follow their movements. This they seem to know; at all events, they are happy. Yet why do they visit us only at such times? Do they belong to one of the "old families" among birds, and did they come in with the glaciers, as some of our friends claim to have done "with the Conqueror"? If so, their love of arctic conditions became so strongly rooted that no subsequent experiences could or have changed it; and in these later days, when the Eskimo and the glacier have alike retreated toward the arctic circle, the larks, too, have followed in their wake, and only return to the homes of their remote ancestors when winter kindly restores it to its old-time condition.

To return to these larks before me: there were fully a hundred of them, and they ran with wonderful speed over the snow, sometimes carrying their heads well up, and then thrusting them eye-deep into the snow. I saw all about me the oblique holes they had thus made, and I judged that it must have been done in picking up grass-seeds that the winds had scattered, and in catching a small red spider that was abundant near the top of the snow, for both of which they were evidently in search. There was also some insect-life abroad—minute black flies, that eluded my efforts at capture, but which may have been caught up by the quick-motioned larks.

Beyond me, the half-hidden worm-fence had protected in its corners a long hedge of tall weeds, and these I found still retained a large portion of their seeds in the seed-vessels. These weeds the larks did not approach. Indeed, they are not adapted to climbing at all, and any food to be accessible to them must be upon the ground.

Again, during the whole time that these larks remained in view, I failed to detect any leader among them. I thought that, in every instance of their taking flight, I heard a clear, bell-like chirp, but there was nothing to indicate that this alarm came from one and the same bird. However this may be, no sooner is the note heard than every bird rose instantly, and, although much scattered at the time, they closed their ranks promptly, and moved with a wavy motion, almost as a single object. I likened it to a sheet of paper carried gently along by the wind. With the same unity of purpose they alighted; no one lark touched the snow a second in advance of its fellows. But no sooner were they again on foot than they were wholly indifferent to each other, and went seed-gathering and spider-hunting, each one strictly on his own account.

It seemed to me, at the time, highly improbable that they could follow this course for any length of time without drawbacks, and I asked myself if they were never molested when wandering over snow-clad fields. Happily for my curiosity, I was soon enlightened. A shadow floated quickly over the snow before me, a faint, cat-like scream came from overhead, and as I turned I saw between me and the sun a restless, impetuous sparrow-hawk hurrying by. It too had seen these merry larks from afar, or, descrying me, had guessed that I was bird-hunting, and so came to see. At all events, on came the hawk, and perched upon a projecting stake of the worm-fence near by. From this "coign of vantage" it sailed over the spot where the larks were, but no sooner was it directly above them than they moved *en masse* a few yards, and, settling down, they scattered again. I could scarcely follow their movements, but it was evident that they were determined not to give the hawk an opportunity to single out any one of their number. In order to accomplish this, they in one instance burrowed into the snow until quite concealed. The hawk, darting like lightning toward them, struck the low snow-bank, and, being disappointed, he rose with a shrill cry of anger and disgust. As he was flying in one direction, the larks rose up as one body, and moved by me in the opposite direction at a rate of speed never attained by any sparrow-hawk. I was fairly thrilled with the suddenness and sagacity of the movement, which was all over before I fairly realized what had happened. I saw no more of the larks that day, but enjoyed the chagrin of the hawk, which vainly endeavored to determine their whereabouts. The baffled bird seemed to hold me responsible for their escape, and scolded me in no measured terms. Either knowing that I was without a gun, or being perfectly indifferent to the fact, he came flitting near me, and darted menacingly toward me as I stood my ground. I have seen brave birds and impudent ones, but none that exceeded this baffled hawk in both these qualities. He evidently held me responsible for all that had happened; at least I thought so, as I slowly wended my way homeward.

CHAPTER XXIV.

FEEDING HABITS OF KINGFISHERS.

In the volume by Mr. Darwin on the "Expression of the Emotions," it is stated, on page 48, that "kingfishers, when they catch a fish, always beat it until it is killed." When I read this statement, I felt quite sure that it did not apply to our common belted kingfisher; and, in a brief communication to "Nature" (vol. vii, p. 362), I took occasion to say that I had never seen a kingfisher take its food otherwise than by swallowing it whole, and that while he was yet upon the wing. The captured fish having been swallowed, or, at least, having disappeared, the kingfisher will then alight upon the branch of a tree, and, stretching out its neck, go through a gulping motion, as if the fish had not been entirely swallowed, but had been retained in the œsophagus. Up to the time when I made this note (January, 1873), I certainly had never once seen a fish taken from the water and killed before being devoured, and I was under the impression that, in feeding, the kingfisher, after darting into the water and securing a small minnow, emerged from the stream, uttering its shrill, harsh, chattering cry, as if rejoicing over the delicate morsel it had captured, and not scolding at its ill-luck, as has been thought. That this is so is evident, because I have shot these birds as they rose from the water, and on dissection have sometimes found in their stomachs or œsophagus an entire fish in which life was not quite extinct. Indeed, I can not see how the kingfisher could utter a prolonged scream with a fish struggling in its beak. When the captured fish, either from its size or from any other cause, is retained in the œsophagus until the bird alights, the movements of the kingfisher in swallowing it are very like those of a pigeon feeding its young. The neck shortens and swells, the feathers are ruffled, and the wings slightly open and shut two or three times.

A further examination, however, showed me that I was wofully mistaken in my original statement. Not having had my attention called to the subject particularly, my casual observations had led me to suppose that I knew the kingfisher perfectly, when, in fact, my acquaintance with the bird was very slight. This dawned upon me when I found the truth of my assertions in "Nature" doubted by many; and also, when I was assured by careful observers that Mr. Darwin's remark did apply to our species of kingfisher. Then I determined to satisfy myself, and I began at once to study very carefully the habits of the bird in question. During 1873 and 1874 I took every opportunity possible of familiarizing myself with the daily routine of its life, with the following result: In 1873 the whole season—from April to November—was spent upon the water studying our smaller fresh-water fishes, and my opportunities were unusually good for observing the movements of a pair of these birds. My daily record of observations shows these kingfishers feeding, from one to four times a day, for eighty-three days; or, in other words, during this period I saw them dive for fishes one hundred and sixty-six times, and either every plunge was unsuccessful or the birds swallowed, before alighting, every fish they had taken; making, of course, due allowance for their occasional failures to seize their prey. This seemed to confirm my original impression, but, as a late ornithologist of note has said, "The horizon of one man is at best very limited, and many ornithological facts occur that are not dreamed of in his philosophy." I repeated my observations through the spring and summer of the ensuing year. My opportunities were equally good, and, much to my satisfaction, I have a quite different story to relate. It is proper, however, to state that during the summer of 1873 my observations were made altogether in a very limited locality—the summit level of a canal—and were confined to one pair of birds. During the subsequent year, I watched the kingfishers in several different localities, and my note-books make mention of these birds from two to six times per day, for one hundred and one days, or a total of about four hundred observations. Of this series I have to say that in eighty-eight instances the kingfisher captured and, alighting, deliberately beat the fish against the limb of the tree, and afterward swallowed it. Thus it will be seen that this habit is by no means constant, as less than one fourth of the fish taken were killed before being swallowed; though, on the other hand, it is evident that I was wide of the mark in stating that the fish is always swallowed without being first killed.

There is, of course, some cause for this difference in the habits of these birds, and I believe it may be explained in this way: as already stated, my observations during 1873 were confined to a single pair of these birds, in one locality; and the obvious reason why these particular kingfishers always swallowed their prey as soon as caught was because they fed exclusively on the very small but extraordinarily numerous cyprinoids frequenting this artificial sheet of water. I know, of my own fishing experience (pursued after a different manner, however), that millions of cyprinoids or minnows were found there, as though they sought in this canal an asylum from the attacks of carnivorous fishes, which are quite rare, as compared with the number in the river near by.

During the season of 1874 I took notes on such kingfishers as were seen about two creeks, a mill-pond, and the Delaware River. In each of these localities large fishes of many kinds are more or less abundant, and the percentage of small cyprinoids—from two to four inches long—being much smaller than in the canal, it would evidently be irksome to so voracious a bird as the kingfisher to wait until fish of the proper size for swallowing without preliminary butchering should come within reach. It therefore, in some measure, seems to depend upon the size of the captured fish whether or not it is killed by the kingfisher before it is swallowed.

Both habits having been found to be true of this bird, it is desirable to know why the habit of killing the fish before eating it should be the invariable practice of this bird in some localities, as stated. I can only suggest that this may depend upon the anatomical characteristics of the fishes caught. When an abundance of cyprinoids, which are fishes with soft-rayed fins, are to be obtained, then little or no preparation is necessary to make them fit for food; but if young perch with their spiny fins, or tough, hard-scaled fish of any family, have to be depended upon, then the kingfisher is forced to prepare the food before it can be safely swallowed.

CHAPTER XXV.

THE SAW-WHET AND OTHER OWLS.

Doubtless the little saw-whet owl can withstand any degree of cold—belonging to a circumpolar family, he ought—but, nevertheless, he is always to be found on the sunny side of a tree, and along hill-sides with a southern exposure. If he comes close to the house, he will find a cozy corner where the sunshine strikes in full force, and where never a breath of the north wind can enter. Twice I have found them on the south side of the barn, where they had arranged roomy nests, and had occupied them for weeks. Not a single nest, large enough for three, but each for itself had a protected perch, whereon it sat and meditated by day, and from which in the evening it sallied forth in search of food, returning, however, long before dark. None of our birds, either resident species or winter visitors, are partial to north winds. Even horned larks and snow-buntings will keep out of the wind and stay on the leeward slopes of snow-clad fields; and when our moisture-laden northeast wind prevails, then birds of all kinds, even to the crows, seek shelter; and miles of walking will not give you, perhaps, a glimpse of a single stray feather.

To return to the saw-whet. Generally in a dense cedar—one surrounded by other trees, and not standing alone—and also in a tangled mass of green-brier or grapevine that has lodged in the upper branches of some tall tree, you will likely find the resting-place of this, the smallest of our owls. A remnant of a leaf-nest, made by the gray squirrels as a winter home, is likewise a favorite roost, and from it the watchful little owlet scans the immediate neighborhood, and knows just where he is likely to find a shrew, sparrow, field-mouse, or *Hesperomys.* It is not his habit, ordinarily, to forage by day, but he is not oblivious to the diurnal movements of his neighbors, nevertheless. If occasion requires, saw-whet will sally out in broad daylight, moving with a noiseless, bat-like flight, but with all the confidence of a sparrow-hawk. It is correct, in a degree, to consider this owl nocturnal in its habits, but not so strictly so that his presence by day should excite any surprise on the part of the beholder.

In speaking of the allied Tengmalm's owl and of this species, Dr. Coues remarks that "they are among the most perfectly nocturnal birds of the family."* If by "nocturnal" is meant that these birds are more active as the absence of light becomes more marked; that their activity increases with departing daylight, then it is not true of them. To say that owls are crepuscular, partial to cloudy days, and delight in clear moonlight nights, is true, just as it is of the herons, night-hawks, whippoorwill, and chimney-swifts; and, among mammals, of the bats. I am disposed, furthermore, to believe that their vision is not as good as that of the night-heron or of a bat on, comparatively speaking, dark nights. I find in our upland woods, if the day is cloudy, that the long-eared owl moves about quite as freely as any of our hawks; and in the meadows, especially during September, when the reed-birds congregate in the marshes, the short-eared or marsh-owl is about by day, and skims quietly over the reeds and tall grasses in search of wounded birds; knowing that many such are to be found by following in the wake of gunners, who murderously discharge their guns at the dense flocks of reed-birds, and wounding a dozen often where one is killed. That the little red owl is quite himself while the sun shines, is known to every country lad. That all these owls love the twilight, no one can doubt; but that their activity increases with the growing darkness, is not true of any of the nine species of owls that I have found in this vicinity.

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* "Birds of Northwest." Page 314. Washington, 1874 (Government Printing Office.)

Although I have found these saw-whet owls at all seasons, I am not quite sure that I have ever heard their voices. The "saw-mill" note, of which Audubon speaks, I have never heard to recognize it; nor the bell-like note mentioned by other writers. When I have captured them alive, they made the usual clicking noise with the beak, and faintly murmured, as nearly as I can express it; but beyond this I have heard no utterance.

A neighbor, on the accuracy of whose observations I can rely, has had better luck in this respect, and describes to me the note of this owl as expressed fairly well by the syllables *tlee-klee, tlee-klee*, twice or thrice repeated. Then an intermission of a minute or more, and the note or notes are repeated. He further says he has heard it during dull, cloudy days in summer, and early in the evening, but at no other time of the year. It is not, of course, to be inferred from this that the saw-whet does not utter its peculiar cry in autumn and winter, or late at night. Being nocturnal in its habits to the extent that are all owls, of course it must do so; but, on the other hand, it is additional evidence that this species is not as strictly nocturnal as has been supposed.

A word about the voices of owls. It is common to speak of these birds as "hooting," but what is meant by this term is not very clear. The little screech-owl has a variety of notes, not one of which is suggestive of a "hoot," as I understand the meaning of the word. The long-eared owl is known here as the "cat-owl," because its voice resembles much the mewing of that animal. The great horned or eagle-owl has the nearest to a "hooting" note, perhaps, but it is far less gloomy than one might suppose. In broad daylight it would attract and interest one; and only because it is heard at night, when few other sounds but the hum of insects are to be heard, does it, popularly speaking, "fill one with dread." These large owls fret, cackle, laugh, and chatter, rather than "hoot." The barn-owls, although abundant, do not often "give tongue." Have they learned wisdom by experience, and fear that by hooting they will only make their whereabouts better known? Not long ago, however, I heard one of them scream to some purpose. On the 5th of May, 1883, my nephew discovered a nest of this owl, containing six eggs and the mother bird. With some difficulty she was secured and placed in a covered basket. With her new surroundings she was evidently disgusted, and soon uttered the shrillest and most unearthly scream I have ever heard from beast or bird. It may be represented by the letters *kr-r-r-r-r—ick!* Commencing as a low murmur, the volume of sound gradually increased until it became an ear-piercing shriek, ending suddenly with a click. The bird at the time opened its beak widely, and closed it suddenly with the ending of the utterance. It was several times repeated.

I say it was the wildest scream I ever heard. Not so; once, a year or more before, while passing along the wooded bank of Watson's creek at night, I was fairly frightened by a wild scream I had never heard before, and failed then to identify. What manner of bird or mammal uttered it was then and subsequently a mystery, until the captured owl screamed as I have described. Then I knew. It was the same cry; but this time louder, wilder, more unearthly than before.

In the interesting series of weather proverbs published recently as "Signal Service Notes, No. IX," there are three references to the hooting of owls, no one of which, I think, merits attention as a weather-sign. It is said, for instance, that "owls hooting indicate rain." What of the owls that cry so persistently during the summer drought that, early or late, is sure to come? For the past eleven years we have had a "dry spell" of four to six weeks' duration every summer, yet the owls did not fail to hoot. So too, in winter, the cat-owls scream every night, whatever the weather.

Again, "if owls scream in foul weather, it will change to fair." Probably, but not because the owls scream. During protracted rain-storms in autumn, and particularly in November, the short-eared owls that frequent the meadows are exceedingly noisy. Day and night, if two or three chance to roost in the same tree, they will hoot in concert, from sunset to midnight, and no more on the day preceding a "clearing up" of the weather than during the first of half a dozen rainy days. More strange than all, it is said, "if owls hoot at night, expect fair weather." When, if not at night, do owls hoot? To be sure, the marsh-owl screams during the day occasionally. So, too, do the snowy and great horned owls; but some unusual occurrence prompts this. Surely, the regular hooting hours of all owls are after they have left their roosting-places and are moving about, either in search of company or hunting for food, and this is after sunset.

The principal food of our owls, except the saw-whet, is the ever-abundant field-mouse. I know that both the snowy owl and the great horned owl capture mice; the former hunting them with much skill, if there are stretches of bare ground accessible, during the weeks in midwinter when these birds visit us. The equally rare barred owl, too, cares more for a mouse than for a chicken or pigeon; and I have long insisted that whatever of valued bird-life, even, these large owls may destroy, really counts for little in comparison to the good they do in destroying field-mice. Certainly, owls, as a class, merit our protection, and should be spared the senseless persecution to which they are subjected. The loss of a chicken or quail or grouse signifies little indeed, when we consider the value of all checks to the increase of mice. These creatures multiply so rapidly, and work so much destruction in cultivated fields the year through, that any mouse-eating animal, whether owl or hawk, is a benefactor to mankind. The persecution to which owls and hawks have been subjected, even in many localities to the verge of extinction, has resulted in losses to the farmer, by the resulting increase in field-mice, quintuple the value of all the poultry that might have been destroyed had birds of prey been reasonably abundant. These may appear rash statements, hastily expressed, but, in reality, are my firm convictions—the results of careful observation and study of the habits of these birds for fully twenty years.

No objection, however, can be urged against the saw-whets, on the score of their diet. In winter, a mouse or a snow-bird satisfies them for a week or more; and during the other seasons, insects, whenever attainable, are their favorite food. Black crickets, brown grasshoppers, and even pea-green katydids, are eaten in large numbers. So, too, the larger moths are eagerly devoured. I am inclined to believe that one reason why we see so few large moths, such as the cecropia, polypheme, promethean, and lunar moths, in comparison to the number of cocoons that are to be found during the winter clinging to the bushes, is that no sooner are the matured insects on the wing than this owl, the little red owl, and the bats, attack them. I have twice found the remnants of many wings of these four moths in the hollows of trees where the saw-whets, for the time, were living. This fact, further, was once very forcibly brought to my attention by an annoying incident. For several summers I have been anxious to secure a good example of the rare walnut-moth (*Ceratocampa regalis*), and during a pleasant August evening last summer was delighted to see one fluttering against the window, struggling to enter the room, where a bright light was burning. I hurried out of doors to capture my prize, but was too late. A saw-whet owl that had been roosting in a pine-tree near by had also seen the moth, and, pouncing down, seized it while I was reaching upward for the same purpose.

Prior to 1877 I had not found any specimens of this owl in the neighborhood. On January 16th of that year, after two weeks of quite uniform cold and snowy weather, it proved warm, rainy, and a dense fog prevailed. A few birds of several kinds twittering in the cedars drew me out of doors, and I found, to my surprise, that the snowbirds, sparrows, titmice, and kinglets had discovered one of these little owls in a cedar-tree, and were discussing its presence with many emphatic chirps and twitters.

It is always a safe conclusion that something unusual has occurred, when different birds congregate about one spot, and are unusually noisy and demonstrative. Remembering this, led me to discovering the saw-whet—the first living specimen I had ever seen.

Since then these owls have been found here every year, not merely as visitors but as residents. They nest in the hollow apple-trees of my neighbor's orchard, and once a nest was built in a remnant of a "leaf-nest" of a gray squirrel. But one brood, I think, is raised.

Young birds of the characteristic, uniform, chocolate-brown color are as common as those with the mottled plumage of adult life. The plumage, in fact, varies much more in this species than with the little screech or red owl. The latter may be red or gray; but the saw-whets vary indefinitely as to the degree of mottling. Particularly is this true of the facial disk. I have seen it pure white, with scarce a trace of color about the eyes; and again, the dark rim of the orbits was so wide that but little white was noticeable as the bird sat facing you. There are many other characteristic features, however, always present, which render it easy at all times to instantly recognize the pretty, innocent, and wise little saw-whet.

CHAPTER XXVI.

NOTES ON OUR HERONS.

If those who are fond of watching the habits of our many birds should happily have ready access to a considerable expanse of meadow, with here and there a clump of trees, and with a creek meandering through it, or can wander along a goodly stretch of heavily wooded river-shore, they will doubtless have abundant opportunities of studying the habits of a class of birds that have ever been to me the most interesting of all.

Being so different from all the others, both in appearance and behavior, and forming, as they do, a prominent feature in the landscape that brings us into closest communion with "untamed nature," these birds, known collectively as the herons or *Ardeidæ*, offer an exhaustless fund of instruction to the field naturalist.

In the vicinity of my home I have noted, during my rambles, the great blue heron, the great white, the snowy egret, the little blue, the green, the two night-herons, and both the bitterns.

The first mentioned of this goodly list is now by no means abundant, and the white egrets are seen even less frequently. The smaller blue heron seems quite indifferent to temperature, and single specimens are often met with in winter, associated with the very common night-heron, which latter is at times a winter resident, though as a rule it is migratory in its habits. As an instance of this I may mention that, during the winter of 1869–'70, and for several years since, a family of common night-herons have occupied the pine-trees in a large and heavily wooded yard in the city of Trenton, N. J. In this yard is a pond which is fed by a lively spring, and which, during the above-mentioned winter, in consequence of the mild weather, was quite free from ice, the vegetation near it being comparatively green. The many frogs, too, were thoroughly active all winter, albeit without much if any food, and the many small gold-fish and silvery-finned minnows in the pond were as readily accessible to the herons as in summer. These frogs and fish afforded an abundant food-supply to these birds from November to April. Occasionally they would go as far away as the river, but they soon returned, having probably taken the flight for exercise and not to search for food.

Least seldom seen, because with us so very shy, of all these long-legged birds, if we except the great white heron, is the least bittern. I have seldom found more than a single pair in the same neighborhood. When disturbed, unlike the big bittern or "bog-trotter," it gives no hoarse croak as it takes wing, but with an easy flight it goes a short distance and drops again into the long grass, where it is, I judge, most at home. It does not feed on fish and frogs exclusively, but pursues with wonderful agility the grasshoppers that climb the blades of tall grass and the stems of reeds. Finding a nest, in 1873, I took a position near by, in hopes of seeing something of the movements of the parent birds when unmolested; but in this I was disappointed, except so far as to determine that they returned to the nest on foot. For the two hours that I watched them they came and went continually, but not once did they fly as high as the tops of the rushes. Dr. Coues has mentioned a resemblance of this bittern to the rail-birds, and, when a good opportunity offers to see them undisturbed, this resemblance in their habits, and especially in their movements, is readily seen. While the larger bittern and the herons have each a stately walk, and perhaps can not run, this little bittern will run whenever the ground will permit; and it can twist and turn in and out among the reeds and rushes with all the agility of a king-rail. I have several times seen them, associated with the soras, run out from the grass to the muddy banks of the ditches, and along them for several yards, and then dart in again, never, the while, taking a step that could be called a "walk." Nevertheless, they can step along most majestically; and when, assuming for the time the proper family characteristics, they fish or go a-frogging, they act their part with due propriety; but they seemingly prefer to act like rail-birds, and in this respect we see in them a similarity to the habits of the shrike when it simulates the hawks.

It sometimes happens that during certain summers many of these herons, of the rarer species, are exceedingly abundant for a short time, and then disappear altogether. This is due, not to any peculiarity of the weather, so far as temperature alone is concerned, but to those occasional excessive rainfalls which result in temporarily flooding the large tracts of meadow-land that skirt the river. These meadows are usually dry, except in scattered small areas, but when submerged they afford a desirable hunting-ground for a brief period. A notable instance of this occurred in 1875.

On Monday, August 2d, of that year, it began raining early in the morning, and continued to rain, except during a few brief intervals, until Friday, the 20th. The wind varied only from southeast to south. About ten and one tenth inches of rain fell in these nineteen days, and, as a consequence, there was a heavy summer freshet, the meadows skirting the river being submerged to a depth of from two to six feet.

On the 14th a flock of thirty snowy egrets made their appearance, keeping much together, avoiding the clumps of tall trees, and at times associating very familiarly with a flock of domestic geese. Occasionally, the great blue herons were seen in scanty numbers, either by themselves or associated with the white herons, and every day there were numbers of the small, blue herons, but these excited no comment from those familiar with the locality, as they are very abundant every year, and at all times. Indeed, these—the night-herons and great bitterns—are fixtures of our meadows, and *not* to see them would be far more strange to "the folks at home" than is their appearance to the stranger, who for the first time sees and hears them, as they are fishing in, or flying over, the creek near by.

August 17th, a small flock of great, white egrets, or herons, made their appearance, and associated familiarly with the smaller, snowy egrets that had preceded them by three days. A tract of level meadow, of some seventy acres in extent, seemed particularly attractive to these birds, and I had excellent opportunities for watching their habits during their brief stay.

It is proper here to mention that even fifty years ago both of these white egrets or herons were much more common along the Delaware River, from May to September, but they have now so far forsaken the neighborhood, especially during the past twenty years, that their presence now excites surprise, even when single specimens are seen "flying over." How great the change has been since the settlement of the country by Europeans, can be realized when we compare our own meager notes of these birds, and indeed of all the herons, with the remarks made by Kalm in the middle of the last century. "Cranes," he says, at the beginning of the century (1700), "came hither [along the Delaware] by hundreds in the spring; at present [1748] there are but very few; and," he adds in a foot-note, "when Captain Amadas, the first Englishman that ever landed in North America, set foot on shore (to use his own words), 'such a flocke of Cranes (the most part white) arose under us with such a cry, redoubled by many echoes, as if an armie of men had shouted together.'" In a subsequent notice of our herons he says, under date of February 17, 1749: "Cranes were sometimes seen flying in the day-time to the northward. They commonly stop here early in the spring for a short time, but they do not make their nests here, for they proceed on more to the north. Certain old *Swedes* told me that, in their younger years, as the country was not yet much cultivated, an incredible number of cranes were here every spring, but at present (1749) they are not so numerous." As Kalm here refers to the western sandhill crane, it is a matter of much interest, for this bird has not been known east of the Alleghanies, except as stragglers, during the present century.

But to return to the white herons. My studies of the habits of birds during the past twenty years have frequently suggested to me that when any bird or flock of birds deliberately choose to frequent a very limited locality for a comparatively long time, notwithstanding the danger occasioned by the presence of man, their habits would show the possession of faculties that can not be considered simply instinctive, but which indicate the exercise of unusual care, forethought, and deliberation, in their endeavors to avoid real or supposed dangers from this source. To what extent this is true is, I think, partly shown in the notes I have taken in the field from Aug. 14 to Sept. 9, 1875, inclusive. Just how these movements should be interpreted the reader must judge for himself, but I think the explanation here given is most in accord with the facts, which I regret my inability to describe as clearly as might be desirable. Valuable as they undoubtedly are, written descriptions give but a faint idea of the varied movements and daily habits of our birds, which must be seen to be really appreciated.

Now it is very evident, I may state at the outset, that these great white herons know that their size and color render them quite conspicuous; and I noticed every day the same movements on their part, which demonstrated their appreciation of this fact. They invariably kept in the middle of the tract of meadow, unless when feeding, and then never ventured nearer than, say, one hundred yards to the wooded margins of the meadow, or to the near outstanding trees. This shyness, as it would be called, was not of itself at all remarkable, but as it was accompanied with another habit having direct relation to it, it was very curious and clearly indicated reason. This other habit was that of rising to a very great height always when passing over woods, as was necessary on coming in from the river, along the banks of which I believe they had their roosting-places. While the less timid blue herons would pass leisurely along the tree-tops, not a dozen yards above them, the great white herons, on being disturbed, or when voluntarily leaving the meadow, would rise rapidly to an unusual height, and, apparently keeping directly over the spot where they had been standing, would not commence an onward flight until the upward one was sufficiently prolonged to assure them that they were wholly out of harm's way. So, when returning to the meadow, they would, as it were, drop from the clouds, while the blue species would quietly wing their way along at a height of from ten to forty metres.

Now, inasmuch as no white egrets have, in any numbers, visited this locality for several years, and as in the Southern States they are little, if at all, more wary than the blue herons, it seems to me to follow necessarily that their peculiarity of flight, as instanced in avoiding supposed dangers, could not be hereditary, and was really an exercise of unusual care and forethought on the part of these birds; a mental operation identical with thought in man, and having nothing whatever in common with instinct as understood by us.

Why, indeed, a flock of these great white herons, for nearly four weeks, should frequent daily a tract of meadow so small as this of seventy acres, it would be very difficult if not impossible to determine; but such being the case, I naturally endeavored to mark their feeding-habits carefully, and this, with the aid of a powerful glass, I was able to do. Their food consisted exclusively, while on the meadows, of frogs and grasshoppers, and especially of the latter, which were very abundant, and which, having been caught by the freshet while in the long grass, were so wet and draggled that they could not escape by flight. The smaller herons seemed always occupied in gathering up these grasshoppers, and never stopped to plume themselves or take a quiet nap, standing on one leg, as the blue herons are so fond of doing. The great white herons, on the contrary, seemed to weary of gathering grasshoppers and frogs, and would spend much time in dressing their feathers; but, while really undisturbed, they never ceased to be suspicious, and the little flock seemed to have a mutual understanding for their common safety, as every fifteen or twenty minutes one of their number would rise well up into the air and circle slowly about, as if to see if the coast was clear. If at such a time any person was noticed approaching, or I purposely showed myself too near them, the flying heron would give a loud, shrill call, and they would all rise up immediately and be gone for perhaps an hour. I frequently disturbed them, and so uniform was their action at such a time, that I could describe in advance to a friend what would be their movements when alarmed. So unvarying was their method of leaving and returning to the meadow that it seemed only explicable by considering it the predetermined routine, resulting from a consultation had among themselves, when circumstances first led them to the spot in question.

As an instance, also, of these birds evidently "studying the situation," I daily noticed a change in their habits, as the waters began to subside and restricted their range of submerged land. Not once did I see these white herons light upon dry land or in any of the trees, while in both places the blue herons did so continually. These more careful, timid if you will, white herons unquestionably realized fully that an open meadow, even when only six or eight inches under water, afforded no cover for their arch enemy, man, but felt that he might crawl dangerously near in the long, tangled grass, now again exposed. The indication of this evident train of thought on the part of the herons consisted in the marked increase of suspicion, and the steadily increasing number of circular flights, on the part of some of their number, to see if any danger was near.

It were useless to endeavor to give a detailed account of their many interesting movements, all of which were so indicative of thought; but the whole series of observations, as I now recall them, and the perusal of my many brief field-notes, more than ever fully convince me that these herons, like all our birds, depend upon and owe their success in life more to the quality of their reasoning power than they do to the mere operations of blind instinct.

While the vocal efforts of the herons can not be commended for their melody, there is, nevertheless, a wealth of suggestiveness in the hoarse *quŏk!* of the night-heron, as it slowly wings its way above you in the dim twilight. The "booming" of the great bittern is by no means an unpleasant sound, except perhaps to those who have no ear for Nature's varied voices, and no eye for beauty, as it is found in precincts man has not marred by his presence. Perhaps nowhere, in this sadly artificial region where I chance to dwell, is there left a trace of primitive times so pleasant to contemplate as the meadow and creek-side, when, in the gloaming, the herons come from their noonday haunts, and fishing in the still waters, or flying from point to point above my head, they call to each other, and express perhaps the whole range of their communicable thoughts in the one, unvarying, monotonous note, *quŏk!*

The scarcely less harsh cry of the green heron, too, is not an unwelcome sound to me, and I always greet with pleasure the first time that I hear it, in the early spring.

A few words, in conclusion, about the nesting and other habits of this well-known bird. Certainly it must be well known, for no bird in the whole fauna seems to be so abundantly endowed with "heaps upon heaps" of meaningless names. Never yet have I heard it called a green heron, heron, or little heron; but always, "poke," "fly-up-the-creek," "chuckle-head," "bastard wood-cock," and so, *ad infinitum.* Why, indeed, these birds should be singled out in this manner, and ridiculed by a multiplicity of defamatory names, I have yet to learn.

As to its habits, there is in nearly every family of birds some one or more species that have taken more or less completely upon themselves habits not characteristic of the family. This is true, in a measure, of the little green heron. It is the least aquatic of all the family; for, while strictly a wader and a good fisher, it nevertheless is not so dependent upon water for a food-supply, and is often found in high and dry fields, looking, I suppose, for grasshoppers. Time and again have I seen them in the woods, where no water was to be found except that which collected about the few small springs, and which often did but little more than dampen the ground. Like our spotted sandpiper, dear "teeter tilt up" of my boyhood, which often builds in the upland fields, and is as much at home on a worm-fence as is the sparrow, the green heron will nest in trees where there is no water near, and remain there night and day, the greater part of the time. Not that they do not visit the nearest creeks, for this they frequently do; but, unlike the herons generally, they are not less a feature of our uplands than are the common birds of our door-yards. Their nests, too, are built much nearer to houses than are those of any other heron. These nests are flimsy structures; often not over a hundred twigs, loosely laid together, constituting the home of the expected brood; and lucky are they if it holds together until they are able to crawl upon some convenient branch to await the growth and feathering of their wings. One little colony of these herons built, last summer, in a clump of birches near the house, and I think one third of the eggs, at least, were broken by falling through the nests; nearly all of which were so open that the eggs could readily be seen from beneath. How the sitting bird kept them warm enough to insure their hatching is a puzzle. That it was accomplished by contact with her body seems incredible. But if wofully poor nest-builders, and painfully awkward brooders, they are attentive parents, and as long as the young herons are dependent, they are by no means neglected.

Among the changes in fauna that have occurred within historic times, the disappearance of the cranes should here be noted. Dr. Turnbull, in his "Birds of East Pennsylvania and New Jersey," remarks: "The Whooping-crane (*Grus Americanus*) may be said to have disappeared, not even a straggler having been seen for some years. It likewise seems to have been once very plentiful; for we read in Hakluyt's 'Voyages,' edition 1589, folio 729, that Captain Philip Amadas and his fellow-adventurers, who visited and explored the coast in the year 1584, 'having discharged their harquebus-shot, such a flocke of Cranes (the most part white) arose, with such a crye, redoubled by many echoes, as if an armie of men had showted altogether.'"

On page 230 I have given Kalm's remarks on the former occurrence of cranes in New Jersey, and referred them to the sand-hill crane of the Western States. Dr. Turnbull considers that the Swedish naturalist referred more particularly to the whooping crane. This may possibly be true; for, as Dr. Turnbull remarks, it was known to breed in Cape May County, in Wilson's and Audubon's time, and stragglers have been seen as recently as 1857. It is more than probable, however, that both species were once abundant, and the sand-hill crane the more abundant of the two.

CHAPTER XXVII.

NOTES ON THE WOOD-DUCK.

Wandering along the weedy, tangled margin of a quiet inland creek, where giant elms and scarcely smaller maples throw sombre shadows at evening and deepen the gloom, I saw moving slowly before me a pretty wood-duck that gave me but a moment to look ere it disappeared, not by flight but by diving, and as it passed out of sight, here and there on the still waters suddenly moved and then likewise disappeared, one after another, several hitherto-unnoticed ducklings. I had no opportunity then to watch them further.

On my way home, however, I fell to thinking, and wondered, considering that wood-ducks built their nests in trees, how it was that they got their young to the water, oftentimes nearly a mile away. It was the month of June, and I purposed solving this question if it should happen to be my good luck to find a still occupied nest. Day after day I searched every probable and possible nesting-place, and finally, where I scarcely hoped for any trace of ducks or even wood-peckers, in an old decayed apple-tree I found a nest with young birds that were just hatched. How I rejoiced over my discovery! and knowing not how soon the old birds might remove the young, I sought for a safe retreat from which I might watch the tree and its occupants; and while the day lasted I held my place, but no ducks came near the brood. I wondered if I had frightened them away. Early the next morning I was at my post, and waited long hours without result, but at last not in vain. In the distance, clearly limned against the cloudless sky, I plainly descried a small duck. Nearer and nearer the object came, and I felt sure that its flight was directed to this very nest. Not so, for to another and larger tree, a hundred yards distant, it finally turned and alighted on an outer branch. It remained there but a moment, and then sailed rather than flew to the nesting-tree; and, sitting alongside of the hollow limb in which were the young, it seemed rather to be contemplating some of its own affairs than concerned about the young ducklings, that, as freely as might a squirrel or mouse, clambered about the limb and over the mother duck. Doubtless they were anxious to get to a more congenial home, and this wish was intensified by the beginning of hunger, for it is doubtful if they are fed at all until they are safely afloat in some quiet pond.

I had not long to wait before the *modus operandi* of the exodus in this case was learned. The old duck, by sounds or actions, gave the little ducklings to understand that they were to follow their mother, and presently she slowly clambered down the trunk of the tree, which grew at an angle of forty-five degrees from the level surface of the ground, and was followed by the ducklings. A curious procession they made, truly, and one that in times of plentiful minks and weasels would doubtless have proved dangerous. No sooner had the last young duck reached the ground than I essayed to follow, but so rapid were their movements, and so zigzag their route, that it was no easy work, as the long grass often effectually concealed them. But I caught occasional glimpses, and found that with but little deviation from the most direct route they had wormed their way to the nearest water.

In less than a minute, probably, I reached a point near them and the spot at which they entered the water; but the old duck heard me, and with a loud "quack," unlike the common quacking of a tame duck, away she flew, while the little ducklings, catching her meaning, dived, I suppose, and hid in the bulrushes along the shore. At any rate, I never saw either the young birds or the old duck again.

There is one fact, too, that has an important bearing on this subject. It is well known to those who have tried to rear young wood-ducks, that the newly-hatched birds have long, sharp, really cat-like toe-nails; and by their aid the little ducklings, while yet bits of shell cling to their backs, can clamber over the limbs of trees, and up any almost perpendicular surface, if at all rough. I have never compared their feet with those of other ducks, but do know that their toe-nails are very sharp and render climbing easy.

It is a common practice in this neighborhood to search for the nests of the wood-duck, and place the eggs under a barn-yard fowl. Young ducks, thus reared, become quite tame, but it is considered necessary, as soon as the young are hatched, to nip the points of their nails with a pair of scissors. Unless this is done, the old women that "'tend poultry" say the young ducks will climb up any wood-work and seek out the nearest water. I was a little skeptical on this point at first, but have been convinced, having seen a brood of young ducks climb up rough boards a distance of three feet, and let themselves down on the other side. These boards were worse than perpendicular; they leaned over toward the ducks. So it matters not where the nest happens to be, as no tree is so smooth that, by hook or by crook, the young wood-ducks could not get down, even if the old birds did not lend them some assistance. From what occurred in my neighbor's poultry-yard, I should think young wood-ducks might venture pretty much anywhere that a squirrel would climb. Their scansorial ability is undoubtedly equal to all occasions, and must be taken into consideration when the manner of the exodus of the young ducks from any nest is a matter of doubt.

Two years later I found another duck's nest. In this instance the nest was fully fifty feet above the water, in a tangled mass of twigs and grape-vine, on a huge buttonwood that grew from the water's edge and towered nearly one hundred feet above the creek. The creek-bank here was a steep bluff of about three fourths of the height of the tree, and over all of the slope was a dense growth of moderate-sized maples, sassafras, and cedars. Having by chance found the nest, I hunted for a tree growing on the bluff that would afford a good view of the nest. Finally succeeding, I took up my position, and with the aid of a field-glass discovered the duck sitting very quietly on her nest. Day after day I returned, and on the sixth from the date of discovery of the nest, the eggs were hatched. Now my interest was fully up to the requirements of the occasion, and I was determined, at all cost, to see how the duck would solve the riddle—as it was to me—of removing these ducklings to the water. Go they must, and that speedily, for the old mother, however desirous, could not carry food to the young—at any rate, she did not. There they were, fifty feet above the water, in a tree smooth of bark and almost perpendicular. How I trembled with impatience to know what would happen, and how long it seemed! Would they climb down so tall a tree? If so, I trusted I should be on hand to witness the descent.

Two days passed, and still these little fellows stuck to their nest, not even creeping beyond its boundaries; but on the third I was rewarded for my persistence, for on taking my position in the neighboring tree, I saw that some of the young had disappeared, and I felt sure the others would soon follow, unless, indeed, their fellows had fallen from the nest. This proved not to have been the case, for, in the course of half an hour, the old duck made her appearance, and now I fairly held my breath as I watched her with my glass. After a moment's rest she squatted closely down on the nest, and a duckling quickly climbed upon her back and nestled closely between her shoulders. The old bird then walked slowly to the very edge of an overhanging limb, and with outspread wings, with a slow, flapping motion of them, let herself down, rather than flew, to the water. The moment she touched the surface of the stream she dived, and left the duckling swimming on the water, and to all appearances perfectly at home. This was repeated four times, when the tender brood were all safely afloat, and as quick to scent danger and flee from it as was their wary mother.

CHAPTER XXVIII.

A SOUTHERLY RAIN.

"What about to-morrow?" I asked Uz, as we stood on the brow of the hill and gazed over the meadows at our feet, now partially enveloped in a silvery mist.

Uz wet his forefinger and held it up, looking closely at the movement of the few fleecy clouds above as he did so. After a brief pause he replied, with the air of one well convinced of the truth of his opinion, "There'll be a southerly rain and ducks."

A word about weather predictions. I am compelled to admit that I have faith in the judgment of men like old Uz Gaunt, when they pronounce an opinion as to the morrow or a day or two beyond; but he, like all other men, fails in the matter of foretelling seasons.

Uz does not like my referring to the winter of 1880–'81. His prediction, which he early made known to me, was quite the opposite of what the season proved to be. He consoled himself, however, with the earnest protest, that he was never before mistaken; and that "covers three more than fifty years" since he commenced solving the riddle of what the winters will be.

"Natur' knows what's comin'," he has often said to me, "and Natur' gets ready for winter, to suit the sort of weather it's goin' to be."

This is a common impression in my neighborhood, and I presume is so everywhere; but it will not stand the test of statistics. Corn-husks, pigs' spleens, goose breastbones, squirrels' magazines of nuts, musk-rat houses, all are relied upon by country people, but not one is trustworthy. Perhaps the position of the dark and light portions of the breast-bones of geese (i. e., geese hatched the previous spring) is more relied upon as an indication of the "open" or cold weather of an approaching winter than all the others; but it can not be of any use, if for no other reason than because, in a number of such bones reported upon by as many different people, there was nothing like unanimity; and, strangely enough, it is yet an open question whether the light portion of the bone is indicative of "open" weather, and the dark portion of cold, or *vice versa*.

What originally gave rise to these various signs is well worth tracing; but it is not to be dwelt upon here.

Having wandered too far already, let us take a back track and return to the hill-top where Uz still is standing. No man who, without any pretensions to "book-learning," studied Nature out-of-doors probably ever excelled Uz Gaunt in correct impressions of Nature's methods. As a sportsman, or "a gunner," as he called himself, he was a success; for no one could excel him in finding game, or in bringing it down. This, however, never worried me, for he generously gave me chances to shoot, although I often failed to secure a duck which he would surely not have missed. But Uz kept himself, at times, when I was with him, so busied about the movements of the birds he sought, and was so interested in determining how nearly correct he had been in his calculations as to their whereabouts, that he forgot to shoot when they were flushed. Not long since, he sculled up to a flock of widgeon which we could not see, but which he "knew" were "just beyond that clump of alders." I had my doubts, and expressed them; but he was very firm. "They're skulkin' in there; now see if they ain't," he persisted, and so nearer and nearer we drew toward the bushes. His gun, already cocked, lay in his lap, and I was ready. Up they jumped, sure enough, and I got in both barrels. Uz never thought of his gun, but exclaimed with pride, "I told you so!" It was enough for him to be correct in his opinion. Is it any wonder, then, that in all matters pertaining to our local zoölogy I should have found him both well posted and reliable?

When the to-morrow I mentioned at the opening of this chapter came, it proved to be a warm, rainy day, with a southerly wind, or "south-southerly," as he always called it. By this he meant that the wind might shift from southeast to southwest, possibly; but at all times would be essentially "southerly." Uz was right in this, and the rain came down in a steady pour, with now and then a very brief intermission; and the river was soon swollen to the freshet stage. The meadows disappeared beneath a covering of shallow waters; and, better than all else, the ducks came.

Early in the morning of the fourth day, Uz and I stood on the hill-top and took a general survey of the country before starting out. He noted the direction of the wind, the general distribution of the clouds at the time, and then, pointing toward the river with a significant nod, quietly remarked, "I said so." I looked in the direction indicated, and, sure enough, a long, zigzag line of ducks was coming up the river. "Widgeon and teal," he remarked after a pause, and then made a move to go to the boat. I wondered how he knew they were widgeon and teal, instead of black ducks and sprig-tails, but forbore asking, and on we walked until we reached the boat.

A light cedar skiff, well trimmed with evergreens, and just large enough to hold us both, it was a pleasant thing to sit in when Uz did the sculling. With a scarcely appreciable motion of the wrist, he caused the boat to move rapidly yet noiselessly through the water, and, in some way past my comprehension, he knew just where a flock of ducks would be, if they tarried in the overflowing meadows. This day it was a repetition of the story that may be told by any one who has sculled after ducks. At times we were too much for the ducks, and, getting good shots, brought down several. Then, again, the ducks were too much for us, and were out of shot, in spite of all of Uz's ingenuity and our united carefulness.

There came a lull in the day's occupation, however, of more interest to me than the shooting. This was when we hauled up for a lunch and smoke. It met with Uz's approbation as well as my own, and, when our pipes were lighted, I drew him out as I had seldom done before. It was a great treat to listen to what I may call a *natural* naturalist, a man that had read no zoölogical literature and never heard of Darwin or Huxley.

"Ducks, it appears to me," remarked Uz, as he gazed at the pile of a dozen lying in the boat, "either have a strong smack of the human about them, or man has a little of the duck about him."

"Why so?" I asked in surprise, for Uz was not much given to voluntary philosophizing.

"Because they are so cunning, and do so many things that we'd do in the same situation. Now, there's the green mallards. They will skulk in long, green grass, and keep their heads movin' with it, just so they can see you, but you'd never mistrust they were around. You don't see a widgeon do the same thing. They'll pitch for some dead stuff, hay or rubbish, more their own color."

"But ducks don't always have these chances," I protested, "and when there's nothing but water they've only an even chance."

"That's very true when we're talking about the river, or some big lake; but I'm talkin' of ducks on these meadows. For something like fifty years I've shot over this tract, and don't know about any other but by hearsay; but if you want to know what I think of our meadow ducks, I'll tell you."

"Well, Uz, I won't interrupt again, and I do want to hear all you've a mind to tell me."

"Take 'em for all in all," Uz continued, "the sprigtail is the shyest duck we have, and I've been outwitted more by them than any other duck; but, dear me! there ain't the ducks now there was when I was a young man. I've seen a thousand at a glance on the lower meadows. Well, as to the sprig-tails, the last time I had a chance at a flock of 'em, worth speakin' of, was nigh on to ten years ago. A good fall fresh' covered all the meadows, except the high knolls, and I went down toward the Swan Island flood-gates on Crosswicks Creek. Not a duck came near the stools for well onto an hour, and I'd a mind to go somewhere else, when I happen to see a bunch of teal makin' right for me. I crouched down, and they came in easy shot, and I blazed away. Fetched three and crippled another, and then, what the snakes should jump up, but a great swad of sprig-tails right back of me! They'd actually been walkin' about in the high grass back of me, and I believe calculated their chances and knew I'd be lookin' for ducks on the water, and not high and dry on the knolls. I'd a good notion of sprig-tails' cunnin' before then, but that made me set 'em down as the cunnin'est of all ducks."

"Perhaps the ducks didn't see you," I suggested.

"Perhaps they didn't, only they did, just the same. Why, boy," exclaimed Uz with unusual energy, "those sprig-tails were within twenty yards of me all the time, and to think I didn't even smell 'em!"

Uz here took a few contemplative puffs, and watched the curling smoke in silence. Then, in his usual quiet manner, continued: "I'll tell you another thing about sprig-tails. More than once I've noticed that they make sort of slaves of smaller ducks. I've seen a dozen sprig-tails circle 'round a lot of stools, and wait until the teal that were with 'em sort of investigated the matter. The teal would settle down near by, and all would seem right; and then the sprig-tails would settle, but always on the off side of the stools; and, if they got very near, they'd smell a mouse and put off. I've often killed the teal in a flock of sprig-tails, and lost every one of the others."

"But isn't it merely that the teal are less suspicious?" I asked, as Uz paused for a moment.

"No, not exactly," he replied; "they are more suspectin', I know; but what I mean is, they go with the teal for the purpose of havin' them go first into doubtful places, and sort of test 'em. If no harm comes to them, then the sprig-tails think it's safe for them, too."

"That is giving them credit for a good deal," I remarked.

"Not a speck more than's due 'em; and here's another way they're cunnin'. They haven't got owls' eyes, I suppose, but go a good deal by smell; and they'll leave the river after sundown, and come in on the meadows to feed when there's nobody to disturb 'em. I learned their dodge, and tried night-huntin', but it was no use.

They'd feed by night where they'd never go by day, but the whole place would be picketed, and you couldn't get anywhere near 'em. Before your boat was shoved off, 'quack!' would yawp some spy, and the whole kit and caboodle would be off. I could hear their splash on the water as they rose up, but couldn't see a feather."

"I've noticed all this too, Uz, but where is it like human nature to do as you've described?"

"Just here—just here. The ducks we've left us in these parts know at a glance that it's dangerous ground for 'em, and so they learn at the start to be extra careful. None of 'em are hatched about here, and couldn't know beforehand they'd ever see such a place; and yet, so soon as the freshets bring 'em up the river, they take it all in at once, and work accordin'. A wild duck is wild anywhere; but 'round here he's wilder than ever; and this bein' wilder only means that he has to be more careful and cunnin', and so he is so. That is why I think a duck has some sort of a mind. It's a hard-twisted subject, I know; but the more I think of it, the more I've a notion that there's a smack of man-nature in wild ducks, or t' other way, just as you please."

"Most people would want stronger evidence than you mention, Uz, to make them think so," I replied, not knowing what to say, really.

"I s'pose they would—I s'pose they would; but the only way to see things as I do is to use my eyes. Follow up the ducks and other critters about here, as I've done, and they'll look very different to you from what they do when you see 'em once a year only, and then in a m'nagerie. Pshaw! boy, it takes years to get to knowing birds and things; but when you do, you'll give 'em more credit for common-sense than the crowd gives 'em. When you're my age, boy, if you follow it up, you'll think as I do.'

"I have been following up this matter for some time, Uz, and have written something about it," I replied, when he had fairly finished his little speech and commenced a vigorous puffing at his pipe.

"Written something? well, that's no harm. Did you have it printed?"

"Yes, certainly; but why not?"

"Well, there's just this about it," Uz remarked very slowly, evidently thinking as he spoke. "It may be all very well to print what you know; but I've a notion that you're not old enough yet to know much about it."

"You forget that you've been my teacher for some years now, Uz," I interrupted the old man to remark.

"Cleverly put, boy; but I was goin' on to say, you don't know ducks as I do; but then—but then—but then, if you wait till you're as old as I am, and see things as I do, the world might set you down as cranky, if you printed what you thought."

"That isn't very encouraging, anyhow," I said, with a half sigh.

"The fact is, boy, that it can't be proved, I suppose; but animals of all kinds are not so wide apart from folks as these very folks think they are. If I've learned nothing else, by shootin' and fishin' all my life, I've learned that. I've seen common-sense in snakes and frogs even; and I'm satisfied there's a sort of family likeness runnin' through the whole of us, whether we've got two legs or four."

"That is the doctrine of evolution, Uz," I remarked.

"Call it what you choose, boy, but it's true; and my pipe's out, and it's time we were movin'." And we continued on our wanderings after ducks.

CHAPTER XXIX.

SHORT STUDIES OF TURTLES.

In the course of my rambles about home I have found that the turtles and tortoises are quite as well represented as the serpents in the fauna of this neighborhood.

In the upland fields and dry woodlands there is one tortoise that is moderately abundant and quite at home. A second is also occasionally met with. All other turtles that we may chance to meet are either of an aquatic or a semi-aquatic species, and have left their usual haunts but temporarily. In the books it is, I know, otherwise stated, and four of the ten species are mentioned as characteristic of high and dry localities; but this does not accord with my experience, and it is thought to be an error.

The one common strictly upland species known, although imperfectly, to everybody, is the box-tortoise or "land-turtle." While this animal usually fails to rouse any particular interest in the minds of those who meet with it, still I never knew a person who did not pause for a moment when one crossed his path. Indeed, it generally happens that the creature is picked up, turned over, shaken rudely, and scanned closely to see if any name, initials, or date has been cut upon its shell. Furthermore, its peculiar structure, its awkward gait, and the habit of promptly withdrawing its head and limbs within its portable house, and suddenly slamming the front door, all cause the passer-by to gaze at it for a while; though these tortoises seldom have been closely followed up and their peculiar lives made familiar to the world at large. To most of us, it is best known as a convenient object upon which to exercise our ingenuity in rude sculpture; and the "under shell" not unfrequently bears the initials, with the date of carving, of some idler who pauses for a few moments thus to cut what will perhaps prove to be the most durable mark that he will ever make in this world. This curious fancy, however, has proved to be not altogether devoid of interest to the naturalist; for, assuming that the dates are correct, it has been shown thereby that this tortoise lives to a great age, and remains throughout its life in one neighborhood. While there is great danger in basing conclusions upon such uncertain data, still it is highly improbable that in most cases these dates are incorrectly given. There are far too many instances known to families living in the country, of marked tortoises being seen at intervals, year after year, for several generations. My father recently informed me that, when a boy, he frequently found a tortoise upon the plastron of which were carved the letters "W. W."; and that his father had stated to him that, when he was a young man, this tortoise had frequently been found by him. The letters were known to be the initials of one who had lived near by many years previously. It was known that eighty years had certainly elapsed since the letters were carved. The tortoise was fully grown, and probably was an old one when marked by William Watson with his initials. In this connection it may be mentioned that the late Professor Agassiz stated the growth of turtles to be "exceedingly slow. . . . I have collected data which prove satisfactorily that our common *Chrysemys picta* does not lay eggs before it is ten or eleven years old, and even then it is by no means full grown."

While to a certain extent carnivorous in habit—it devours earth-worms greedily—the box-tortoise is essentially a vegetable feeder, and in summer depends largely upon berries growing upon the ground. Strawberries, dewberries, and, later in the year, windfalls from fruit-trees, form an important portion of their food. Decomposed animal matter, also, is freely eaten. Dull, stupid, and sluggish as these tortoises appear to be, they are not really so inert as is usually thought. When two or three are gathered together, and are left to themselves, they exhibit a considerable degree of animation, and give evidence of an intercommunication of ideas. As the result of watching a pen of tortoises, myself remaining motionless and unseen by them, I became satisfied that they took much notice of each other. They would often face each other and crane their necks to the utmost, then quickly, and with frequent repetition, snap their jaws and occasionally utter a faint squeaky note, not unlike that of a mouse. I have seen them, also, strike at each other with their fore-feet, evidently in play, and then scamper off in opposite directions with all possible speed. They are likewise prone to anger, and have been known to fight fiercely over a small supply of food. These contests are a matter of jaws and toe-nails, both of which are brought into play, but I never knew the foot of one tortoise to become fastened in the shell of its opponent.

I have never, to my knowledge, found the eggs of this tortoise, but suppose that they are placed in the earth in much the same manner as those of the aquatic species, which leave the water early in the spring for the purpose of ovipositing. More strangely still, I have never found any very young specimens of the animal. The smallest box-tortoise I have ever seen measured something over two inches in length, or about one third the size of a full-grown specimen. Considering the number of adult tortoises seen, this is the more remarkable, and I am led to suppose that when very young they frequent localities different from those in which I have chanced to ramble.

There is a second species of land-tortoise occasionally found in central New Jersey, known as Blanding's tortoise. It is a very different creature in every way, and the two specimens that I have found were as fierce and snappish as the preceding was mild and inoffensive. Both specimens were found in high, dry, upland woods, though, as a rule, they are supposed to frequent damp, swampy localities. Beyond its exhibitions of temper I learned nothing of its habits.

In the high and dry woods it is quite unlikely that any other species will be found. If a running brook be near by, all the aquatic species will at times be found, throughout the early spring, on their way to suitable spots wherein to lay their eggs; but their sojourn in such a locality is temporary, lasting but little if any longer than a month. All the turtles, except the two mentioned, are essentially aquatic, or dwellers in such damp localities that the term "aquatic" is scarcely inappropriate.

The first of those found, either in the water or in the wettest of woodlands, is the rough-backed terrapin, or "diamond-back," as it is more commonly known. I say "first," because it can thrive more easily without access to running water than either of the species hereafter mentioned. This turtle or terrapin, as it is more usually called, is considered a great delicacy by epicures, and has been so persistently hunted that now it is quite scarce.

I know a few wooded nooks, here and there, where they can always be found, and for several years I have been accustomed to meet with three old individuals which, in 1874, I carefully marked. Every summer I find them, and I am almost persuaded that they recognize me. There is in this secluded haunt of these turtles a bubbling spring, which gives them water enough for a bath, though it is not deep enough to afford them the luxury of a good dive and a swim, such as delight those that live in the meadows. So far as I could determine, these turtles ate animal food exclusively, and appeared to burrow in the mud about the spring for grubs, earth-worms, and such animal life as there abounded. That certain plants, also, were eaten, is probable, but I never saw them in the act of eating any vegetable matter. It is difficult to realize how little can be learned from watching turtles. I have often sat for an hour or more, painfully quiet, in hopes that the turtles before me would go foraging, or at least ignore my presence and act as if alone, but usually without success. Once aware that a possible enemy is near, and the turtles will remain as quiet as you aim to be. The most that can be expected, is to come upon them suddenly when busy feeding or otherwise engaged. Then, possibly, they will not desist at once, and you may have a chance to make a note of what you saw. Years in this way may roll by, and at the last you will find yourself quite unprepared to say much about them. This, I regret to say, has been my experience. In the "American Naturalist" for March, 1870, the method of depositing the eggs of the female rough-backed terrapin is thus described: "The animal dug a circular ditch about thirteen inches in diameter, heaping the dirt in the center, and then threw out this pile of loose earth until the hole was about six inches deep. In this depression was deposited eighteen eggs, which were carefully covered and the earth made firm above them." I have found many eggs of turtles in the earth of recently-plowed fields, but never witnessed the animal in the act of preparing the ground or depositing the eggs. That all turtles exercise about the same care as does the rough-backed terrapin, is probable.

Quite early in autumn these turtles go into winter-quarters, which in some instances is in the mud in immediate proximity to springs. Here the water keeps the earth at a uniform temperature, and free from ice even in the severest weather. Early in April the long sleep is ended, and quite limp, and I judge very hungry, out come the turtles and live on sunshine for many days. By the beginning of May, however, they seem to regain their vigor and appetite, for then they have been seen to dive upon the little cricket-frogs, or "peepers," which swarm by thousands in the meadows and swampy sink-holes in the uplands.

Muhlenberg's turtle is an exceedingly dull-colored, unattractive species, having no bright points or lines to relieve the uniform brown-black of its upper shell. The species may be at once recognized, however, by the large, usually confluent, bright orange spots on the back of its neck. Nothing at all similar to these spots is found on any other of our American turtles.

Early in May, 1881, I was so fortunate as to find two pairs of these rare turtles. They were in the mud of a shallow ditch in the meadow. Their movements, when discovered, were exceedingly sluggish. They made no effort to escape, and when handled offered no resistance. On the contrary, each withdrew its head, feet, and tail within its shell, making a scarcely audible hissing sound as it did so.

These four specimens I kept in captivity for a short time, and then placed them in the Museum of Comparative Zoölogy, at Cambridge, Massachusetts. Before parting with them, I determined conclusively that these turtles possessed well-defined vocal powers; but I have not been able to learn that in their new home they ever exercised them in the hearing of their custodian. To this subject I will return.

In May, 1882, my son found a single specimen of these turtles in a small swamp. It was crawling at the time on the muddy margin of a spring brook. This specimen was placed in an inclosure about six feet square, in which was a shallow basin, filled with water, sunk to the level of the ground. This basin of water was at once discovered by the turtle, and straightway occupied, to its evident satisfaction. In the course of a few days the turtle became quite ill at ease, and wandered restlessly about, anxiously looking for some opening in the pen—as I thought—through which it might escape. Finally, it dug a shallow hole in one corner of the inclosure, and sat therein much of the time. I had hopes that it would burrow deeply, and thus make an effort to escape; but it did not seem disposed to do so, although the earth was a loose sand, through which a land-tortoise could have made rapid progress. I therefore incline to believe that in winter these turtles hibernate in the mud, beneath the water of ditches or ponds, rather than bury themselves in higher and drier localities.

Ten days later my son was fortunate enough to find a pair of these turtles, in the same meadow-ditch from which I had taken my specimens the preceding summer. These turtles were evidently mated. They certainly were very affectionate, and remained constantly together. Here it may be well to refer to a passage in Agassiz's monograph on our turtles. On page 300, he remarks:

"The legs"—of turtles—"which, as in lizards, seem to be subservient only to locomotion, perform, in addition, functions which we would hardly suppose in these animals. Professor Jeffries Wyman had once the rare opportunity of watching two painted turtles while making love, and he saw the male caressing and patting the head of the female with its fore-feet for several minutes."

On the 3d of June, my son found a second pair of these turtles. I had now five individuals in the inclosure referred to. The small basin, which was kept well filled with water, was the point of attraction of their cramped surroundings. It was continually occupied by three of them, as there was no room for the others; but, on the other hand, the others closely watched the occupants of the basin, and promptly took their places when they ventured forth for a stroll about the pen. It was a contest between the "ins" and the "outs" the while; but, so far as I could discover, was carried on quite good-naturedly. Nothing like fighting was noticed, although I closely observed them—myself unseen by them—daily, for a long time. Their appreciation of the little basin of water quite convinced me that these turtles are essentially aquatic, and not a "wood-tortoise," as they are called in the text-books. Two, probably three, of the five individuals were females, but no eggs were deposited, nor did I find any evidences of digging in the inclosure, as though a desire for ovipositing possessed them. The breeding habits of Muhlenberg's turtle are, I presume, essentially the same as those of the rough-backed terrapin, the nearest allied species. This common turtle digs a hole some six or eight inches in depth, and twice this measurement in diameter. The bottom is patted down with the fore-feet until quite firm. In this excavation the eggs are deposited, and subsequently very neatly covered by the loose earth which had been removed. In fact, nearly every trace of an excavation having been made is carefully removed.

As to the whereabouts of the Muhlenberg turtles, except in early summer, I am wholly "at sea." For many years I never saw a specimen at any time, and my experiences of the past two years cover only the months of May and June. That they are not in the same shallow ditches later in the summer, wherein both my son and I found them in May, I am very positive. That they are wandering about the woods, howsoever damp they may be, seems to me quite improbable. I have instituted such careful search for them in the very localities where, if wood-haunters, they would surely be, that it is incredible that any of them should have been overlooked. Indeed, the five specimens captured during the past summer were liberated June 15th, and placed in a small brook that ran through a low-lying, densely-wooded valley. Up to the present time (August) no trace of them has been discovered. Were damp woods the summer haunts of these turtles, they would certainly not have wandered far away; and I doubt their being possessed of sufficient cunning to elude my eager search for them. But one other locality suggests itself, and this is the deeper waters of the tide-water creeks, and those swamps that are deep by reason of quicksands. Here, it may be, the summers and winters of this turtle are passed. Indeed, I found that the Muhlenberg turtles that I kept in confinement could readily remain under the surface of the water in an aquarium for several hours without apparent inconvenience; and when, later, an individual of this species was associated with one each of the mud-turtle, the painted turtle, and the spotted turtle, in an aquarium, the Muhlenberg proved to be as active a swimmer, and remained voluntarily as long beneath the surface, as any of the others. In fact, in its movements and degree of activity, it most closely resembled the mud-turtle, which is so essentially an aquatic species. Referring to the respiration of turtles, Professor Agassiz remarks: "In mud and soft-shelled turtles, the lungs being much reduced in size and importance, by far the greater part of the respiration must be performed by the skin of the whole body, which is much thinner in these families than in other turtles; while, on the contrary, in . . . the *Testudo* (box-tortoise) the powers of respiration are no doubt performed entirely by the lungs" (*loc. cit.*, p. 276). In the case of the Muhlenberg turtle the skin is not thick, but, being greatly wrinkled, appears so; and the lungs are, I believe, of about the same size as those of the strictly aquatic species. Certainly they are very little larger, and correspond more nearly to those of the snapper than to the terrestrial box-tortoise. Therefore, I am disposed to consider, and feel little hesitancy in asserting, that the Muhlenberg turtle is essentially an aquatic species.

A few words concerning the vocal powers of this turtle. In brief articles on the habits of our turtles, published in years past, I have mentioned the voice of the common snapping-turtle. Since then, I have been fortunate enough to hear this same turtle make similar sounds in its native haunts. In every case they were made at night; but my opportunities were such that I am quite positive that the sound heard and the turtle seen were correctly associated.

In the often-mentioned monograph by Professor Agassiz, that author remarks: "Turtles have a voice. Though I have myself made this observation only in a few species, namely, in *Emys elegans*, *serrata*, *picta*, and *insculpta*, which emit a piping note; and in *Chelonia mydas*, whose voice resembles somewhat a quaint, low bark; I am inclined to believe that all of them have, more or less, the faculty of emitting distinct sounds" (*loc. cit.*, p. 284). It is not to be wondered at that our turtles should have voices, for they are by no means such sluggish, indolent creatures as is supposed by those who have only observed them indifferently or from afar off. I have frequently seen them get up a "square fight" over some delicate morsel, as a dead fish or drowned squirrel; and again, while peering over the side of my boat into the clear depths below, I have watched the spotted turtles, two and three together, go through a variety of erratic movements, strongly suggestive of play. Even the solitary land-tortoises, when they meet, will gently touch their noses and go through other movements indicative of the exchange of ideas. Indeed, I have never seen any animal as high in the scale of development as fishes, that did not possess some means of communicating its ideas to its fellows. In no other way can many of the acts of these animals be explained.

To return to the turtles. In May, 1881, my first specimen of Muhlenberg turtle was kept in a small vessel of water, for several days, in a darkened room. Twice, while in the room, I heard it utter a shrill note, which may be represented by the syllables *prēē-ēăk*, twice or thrice repeated; the last time less distinctly than the previous utterances. To make it the more certain that the first utterance was not wrongly attributed to the turtle, I caused a ray of light to be thrown upon the vessel containing the animal, and I remained in the dark, but quite near at hand. I could plainly see every movement of the turtle, but do not think I was seen by it. After the lapse of half an hour after the first utterance heard, I saw the turtle come to the surface, and crane its neck as far out of the water as possible. Opening its mouth widely, it made the same utterance, and repeated it, after an interval of probably ten seconds. The sound was different from that of the snapper, but the movements accompanying the utterances were identical. Since then, I have not been able to detect any evidence of vocal powers; but it must be borne in mind that in my subsequent studies of these turtles I had several associated; and if, as I suppose, the note I heard is really a "call," then it would only be uttered by solitary individuals, when in search of a mate.

Early in summer, if at no other time, the voice of *the turtle is* heard in the land.

The pretty speckled turtle next commands our attention, and although a very abundant species, it may yet be studied to advantage without fear of repetition, as there remains much to be said as to its habits.

This turtle is at once recognized by its jet-black shell, sparsely sprinkled with small, round, bright-yellow spots. It can never be mistaken for any other species. Strictly aquatic in habit, it favors quiet waters, and is essentially inactive except during the breeding season. Then it is very restless, and comes into ditches where it is not only impossible to swim, but where the water is so shallow that its shell is exposed as it crawls over the mud. At such times they are found in pairs, and are very demonstrative. However inert they may appear at other times, they are, throughout the month of May, more like all the rest of animated nature, and they then give evidence of capabilities of exertion not apparent during the summer and autumn.

Like all the turtles, when the weather has become fairly warm, and the surface soil has lost much of the dampness of melted snows and spring rains, this species is found wending its way to the upland fields, in search of suitable places for depositing its eggs. That the same spots are frequented, year after year, is not probable. I have often marked turtles that I have found in May, in sandy fields, in hopes that at the same time in succeeding years I might again see them; but in no instance have I been successful. While these animals remain in the same pond or creek throughout their lives, as I have proved by many experiments, it would seem that, unlike many birds, they seldom, or only by chance, deposit their eggs in the same place. The distance from water of the localities chosen for ovipositing varies greatly, and this would seem to indicate that great care is exercised in choosing the site for this purpose. Often I have found these turtles wandering over hot, dusty fields, that had been recently plowed, where every square foot for acres seemed well suited to their purpose; and still on they went into apparently less favorable fields, where they halted, perhaps half a mile from water. It is proper, however, to add that I have never found their eggs at a greater distance than this from the streams or ponds which the species frequents during the summer.

To what extent these turtles are active, and how they pass their time when in the water, I am not prepared to say; but on bright days they are fond of basking in the noon-day sun, and, in company with the larger red-bellied turtles, they are often found resting on a floating log, or perched upon a projecting stump. At such times they are quick to scent danger, or hear it, and when approached they promptly slide from the log or stump into the depths below. Their eyes and ears are then depended upon; "the sense of seeing," according to Professor Agassiz, "and particularly that of hearing, being highly developed, . . . the sense of smell much less so."

The sense of seeing is not only highly developed for the needs of the day, but it is also available for wandering and hunting at night. From the fact that I have frequently found them moving about at that time, I judge that their vision is largely like that of the owls. Certainly, during moonlight nights aquatic turtles of all kinds can be found more frequently than during the day.

Fully as common, and far more handsome than the preceding, is the pretty painted turtle. The beautifully variegated shell—red, yellow, and blue-black—of this species makes it a very prominent object in the assembled attractions of a clear, sandy-bottomed pond; and though it frequently dwells throughout its long life in the muddiest, gloomiest ponds of marshy, weed-grown meadows, yet I am persuaded that it prefers clear waters, where its bright colors show to advantage. In the month of May, a pair of these turtles can not be observed for any length of time without showing conclusively that these bright colors are appreciated among themselves, and that sexual selection has been the potent factor in the evolution of these prominent markings of the shell. An interesting fact, in connection with this phase of bright coloration, is that the painted turtle is much more diurnal in its habits than any other of the aquatic species found in this vicinity. It is possible that this assertion may be claimed as mere fancy on my part; but I do not fear the result if any of my readers will follow these turtles closely for weeks and months. It is only by such means that they can be successfully studied; and the inference I have drawn, based upon hundreds of observations, is, as I have stated, that this turtle is more diurnal in its habits than any of the others. Whether this fact and that of the bright coloration of its shell have any connection, must be decided by each one for himself. My own conviction is, that they are closely related.

The large red-bellied turtle, which formerly was the most abundant of all our aquatic species, has of late proved to be quite rare. In quiet ponds and sluggish creeks, if shaded by heavy growths of timber, nothing was more common than to see scores of these black-backed turtles, perched upon every projecting stump and floating fragment of wood. Here, apparently, the live-long day they would quietly rest, never, as it seemed to me, volunarily returning to the muddy depths from which they had come. They were ever on the alert, however, and although I often approached them carefully, yet they always knew of my coming, and with a gentle gliding motion they passed so quietly into the water that scarcely a ripple was caused by the movement. In midsummer they remained on their floating perches far into the night, and I often wondered when they sought their food—if, indeed, they ever did anything but float about lonesome waters on rotten logs, or pass their time in quiet contemplation, perched upon every convenient projecting stump.

These were the thoughts of thirty years ago, but since then I have had too few opportunities to study them more closely.

De Kay says of them, "They are brought to our markets—New York city—from New Jersey, where they are very numerous in running streams. As an article of food they are equally prized with the preceding" (rough-backed terrapin). Probably the fact that they are so prized as an article of food has had much to do with their gradual disappearance in many localities where they were once abundant.

Of its habits generally, I am ashamed to admit, I know nothing.

Modern civilization, fortunately, has not as yet devised any means of utilizing the unattractive mud-turtle; so they remain, as of yore, fairly abundant in all muddy streams, ponds, and ditches. I know those best which frequent the ditches in my meadows. These ditches are now quite like natural water-courses, by virtue of the green banks and weedy growths which all summer choke the sluggish current that passes slowly through them. Through these weeds, and in the foot or more of mud that sustains their growth, these turtles, "mud-diggers" as the boys call them, pass their seemingly monotonous lives, seldom poking their noses above the surface. Of course, in spring, they take an overland journey to some sunny, sandy field to lay their eggs. Having accomplished this, they hasten back to their proper homes, and this is the extent of their travels. Do they cogitate, on their return, over what they saw in the outside world? They have little brains, to be sure, but as they often prove that they have a modicum of common-sense, it is not altogether impossible.

Unlike the preceding species of aquatic turtles, this one shuns the sunlight, and keeps closely to the deepest holes that it can find. Here they dwell in company, often a hundred or more together, remaining throughout the day comparatively quiet. At night, however, they are fairly active, and, guided by the sense of smell, they hunt for such animal food as may chance to be available. I say active at night and passive by day, for, when fishing in the daytime, I have caught them but very seldom when compared with the frequency with which I have taken the odoriferous musk-turtle; but when bobbing for eels, or fishing at night, I have often been disgusted at the way in which they seized my hooks. From this simple fact, I believe that they are more strictly nocturnal than the other mud-turtle just mentioned. Here, again, the subject of color comes to the front. This nocturnal mud-turtle has not a vestige of beauty about it. It is superlatively homely, and so it is fitting that it should be nocturnal in habit. Possibly, it has greater vocal powers than the others, but this I can not say. Now, on the other hand, the strongly-scented musk-turtle, popularly known by an expressive but scarcely mentionable name, is quite handsomely marked with lines of brilliant yellow on a black background; and, furthermore, although a mud-turtle, it is quite diurnal in its habits, and even wanders into the clear waters, where it can exhibit its attractions to the best advantage. It can scarcely be mere coincidence, that bright colors and diurnal habits always go together.

A curious appearance is given to these mud-turtles, at times, by the growth of a grass-like plant over their upper shells, which gently waves to and fro in the water as they move along. This plant does not seem to be affected by the habit of the turtle of burrowing in the mud. It thrives even there, and when the animal emerges from its burrow the plant is quickly freed of all foreign matter by the water, and waves as freely and is as brightly green as before. This same growth is common also to the fierce snapping-turtle, of which more anon.

Mud-turtles are mere scavengers. Those that I have kept in aquaria would never take living prey; but no sooner was the fish or frog killed than they would devour it greedily. Even when snappers set them the example, they seemed willing to remain hungry rather than seize a fish while yet a spark of life remained. When, however, a dead fish was placed before several of these mud-turtles in a small aquarium, their mental powers were readily brought into play; and each turtle, in the endeavor to appropriate the entire fish to itself, would bid defiance to its neighbors. In one instance, the largest turtle covered the fish with its shell and endeavored to keep the others off, while, at the same time, it tried to get an occasional bite at the jealously-guarded tidbit. In this manœuvre it was not successful; and it was quite evident, from the free fight that ensued, that their distant kinship to man is no theory, but a demonstrable fact, if their exhibition of anger and the very human-like way in which they fought has any bearing on the question. If, however, there is nothing for them to quarrel about, they are as peaceful as lambs.

When it is said of the musk-turtle that it is not so strictly a mud-loving species as the foregoing, and that it is almost as active by day as by night, we have about covered the ground, so far as its habits are known. In all respects, it is like the other water-turtles as they appear to the casual observer. There are some points of interest connected with it, however, which may properly be noted. According to Professor Agassiz, with the exception of the snapper, none of the turtles that I have mentioned catch active prey, or are in any way ferocious; they are, indeed, entirely harmless, and "only when hard pressed, defend themselves by biting. Their food is both vegetable and animal; the latter they tear with their jaws, holding it down when necessary with their forefeet." Another exception to this generalization is that of this musk or stinking turtle. In an early volume of the "American Naturalist" I referred to this species as follows, in connection with the habits of a curious little fish, the mud-minnow: I remarked that these minnows are exposed to attacks from a voracious animal, which takes advantage of the habit of the minnow of lying more than half buried in the mud. The musk-turtle is able to discover the whereabouts of the mud-minnow without alarming the fish, and, cautiously approaching from behind, seizes it by the head. This they generally completely sever from the body, and then draw from the mud the decapitated body.

I have lately had specimens of these turtles in an aquarium, in which I placed a number of mud-minnows; and have seen the turtles time and again seize the fish with all the dexterity and quickness of a snapper. I believe this habit has gradually come about much in the following way: These mud-minnows have a curious habit of assuming the strangest positions, often quite unlifelike, and maintain them for many minutes at a time. They might readily be mistaken for bent twigs or lifeless, distorted fish. Under these circumstances, a prowling musk-turtle, seeing a mud-minnow which it supposed to be dead, might snap at it in a somewhat leisurely way and succeed in seizing it. More frequently, however, it would fail in the effort. Want of success would, however, insure greater caution and quicker movements on the part of the turtle, and finally result in establishing the method of stealthy approach and quick snap that characterizes the true snapping-turtle. Whether this explains the origin of the habit or not, certain it is that the musk-turtle does now seize active, living prey, and that it exercises much caution in approaching, and dexterity in seizing it.

The last of the series of ten species of turtles found in this vicinity, but by no means the least, is the ferocious snapper.

This is our largest and fiercest turtle. In many ways it differs materially from all the others. The common name "snapper" is derived from the manner in which it seizes its prey. This snapping movement is not, strictly speaking, confined to this species, as has been shown, but it is intensified, as it were, among them, and is withal so sudden and effective that it dwarfs all like efforts on the part of the other species. When a fish is seen approaching, the snapper, even in the close confines of an aquarium, withdraws its head, and at the same time elevates its body by its fore-feet; then, if the fish comes near enough, the neck of the snapper is suddenly lengthened, its body thrown forward, and the fish seized. Once let the powerful jaws close upon the victim, and nothing can force the turtle to relax its hold.

Fish are not, however, the only food of the snappers, as they do not hesitate to attack anything in the way of beast or bird that they can seize, and if they succeed in drowning the animal that they have caught, they soon make a meal of it. I have known a quite small snapper to seize a full-grown musk-rat by a hind leg and drag it into deep water, where I suppose it was held until drowned. Certainly, numbers of young ducks are annually destroyed by these voracious creatures.

When on land, the snapper seems to be quite at home, although his movements are very awkward in appearance. They are not, however, really so, as their rate of travel overland is greater than that of any other of the strictly aquatic species of turtle. The late Dr. Holbrook, in his "American Herpetology," says, the snapper "moves along with head and neck stretched out, moving them to and fro as he proceeds, as though inspecting the ground as he goes. His walk is said to resemble that of our alligator; like them, falling now and then on his sternum to rest, and then proceeding."

In New Jersey these turtles vary, in successive years, as to the time of leaving the water for the purpose of laying their eggs. I have occasionally found them as early as the first week in April, but usually not until a month later. My impression is that they do not wander so far from the water, and are less particular about the localities chosen for depositing their eggs than are the other turtles. I have often found them but two or three hundred yards from the pond or creek from which the animals had come. They dig quite shallow beds, comparatively, in sandy soils, and place therein their whole complement of eggs. Once laid, no care seems to be exercised in covering the spot, and so it is readily found. Skunks have a decided liking for their eggs, and may frequently be found, during moonlight nights, digging them up. Indeed, in isolated spots, the skunks will be abroad during the day, and dig out the eggs as soon as the fierce old snapper has left them.

It is at this time of the year that we may most confidently expect to hear the snappers make that peculiar sound which comprehends their entire range of vocal powers. It is a hoarse "kwēēp," much like that of the Muhlenberg turtle, and uttered under similar circumstances. In thus limiting their vocal utterances to a single sound I may perhaps be somewhat hasty, but, after years of patient watching, I have never heard any other that could be confidently attributed to them. Old fishermen and snapper-hunters have told me, however, that they do occasionally make a deep roaring or bellowing sound, by which I understand a roaring sound heard at a great distance. Such a sound I, too, have heard coming, as I thought at the time, directly from the water, but I never saw a snapper in the act of uttering it; so I can only mention a peculiar, hoarse note, like "kwēēp," which, to my positive knowledge, is often made by them early in May, or just previous to the time of their leaving the water for the purpose of depositing their eggs.

No sooner are the young snappers free from the egg-case than they make their way directly to the nearest water, guided, I suppose, by the sense of smell. Once in their proper element, and their activity becomes very noticeable. All the day long they paddle ceaselessly about, snapping at every minnow and insect in and out of reach. According to Professor Agassiz, this snapping habit commences wonderfully soon in life. In his famous "Contributions to the Natural History of the United States," he says: "The snapping turtle . . . exhibits . . . its ferocious habits even before it leaves the egg, before it breathes through lungs; before its derm is ossified to form a bony shield, etc.; nay, it snaps with its gaping jaws at anything brought near, though it be still surrounded by its amnios and allantois, and its yolk still exceeds in bulk its whole body." And again: "I have seen it snapping in the same fierce manner as it does when full grown, at a time it was a pale, colorless embryo, wrapped in its fœtal envelopes . . . three months before hatching." What, then, may we not expect from this animal when it reaches a foot or more in length? To it, indeed, may be attributed the scarcity of much of that animal life now frequenting our waters. On the other hand, the snapper seems to have no enemies to bother it, unless it be such as prey upon the very young. Can it be that their undue increase is checked by mammals, like the skunk, which hunt and devour their eggs? When we consider this immunity from the attacks of enemies, and the numbers of eggs that an adult annually lays, the number of snappers found in any one locality is not very great, and hence it is evident there must be, somewhere, a check upon their increase.

We might be led to suppose, from their activity and the enormous quantity of food consumed, that the growth of the young snapper was very rapid for the first two or three years; but this is not the case. Agassiz determined that when a snapper was six and one half inches long, it was twelve years old; when twelve inches long, it was thirty-eight years old. After twelve years he states that growth is much slower, and mentions one instance of a growth of but one inch in forty-five years.

I have not been able to learn what may be considered the maximum size of this turtle. In fact, there appears to be no limit to their growth. I have seen one specimen that weighed just sixty pounds, and have been told of others considerably heavier. Specimens weighing over thirty pounds, however, are not common.

A few words, in conclusion, with reference to a habit common to all our turtles, that of hibernation. On the approach of cold weather these animals, as a class, are supposed to bury themselves deeply in the mud at the bottom of ponds and streams, and there to remain until every vestige of winter has disappeared. This is the common impression, though I question if it be strictly true. Careful examination will show that the supposed torpidity has, in part, no real existence. Indeed, the habit is affected very materially by the severity of the winter; for when there occurs a very green Christmas, it is not a remarkable occurrence to find a box-tortoise on the sunny south side of some wooded slope. Languid and limp, it may be, but it will be found to have enough vitality to enjoy a midday outing, and vigor sufficient to enable it to return to its quiet underground retreat toward the close of the day. In most ponds of any considerable extent, frequented by turtles, there are one or more deep holes wherein many of the different species are found to take refuge after the first hard or plant-killing frost. Here they remain, in the deeper and warmer water of these holes, when the shallower portions of the ponds are coated with ice. Now, do they lie in the mud in these holes in a torpid condition?

Throughout the winter, in these same deep holes, I have found that many of our fish also congregate; and the turtles, to a certain extent, during the winter prey upon these fish; the snappers occasionally catching one, and the other turtles feeding upon the remains of the snapper's feast. What first gave me this impression was the fact that I frequently found in nets set under the ice, even in midwinter, fishes that had been partially eaten; and as this occurs quite often in summer, I took it for granted that the offender—a turtle—was the same in each case. Led by this inference, I baited hooks and placed them in the deep holes of a large pond, and in several instances succeeded in catching specimens of the stinking or musk-turtle.

Snappers, in the same way, have been caught during the severest cold weather, in the deep holes in ponds, and about large springs that discharge their waters on level ground. It would seem, therefore, that if the water remains above the freezing-point, these turtles continue in a fairly active state, even though they do not find any large amount of food. In such spring-holes, the grass remains green throughout winter; a few frogs linger in the waters; an occasional bittern haunts the spot; pike, too, are not unusual, and the snapper therefore has company, at least, and occasionally he makes a meal of some one of the hardy visitors which, like himself, brave the winter, and does not seek to avoid its rigors by a protracted, torpid sleep in the mud.

Of the series of ten species of turtles that I have mentioned, some of them, it may be, are so sensitive to cold that they hibernate regularly, and for about one half of the year; but in the case of the snapper, mud-turtle, and stinking or musk-turtle, the habit at best is neither general nor regular. And yet it is probable that these three species, though they do not hibernate regularly, yet do so when cut off from access to the atmosphere by the growth of thick ice; for, while these turtles can stay under the water for a comparatively long time, yet, if all their other functions are active, respiration must necessarily be active also; and it is questionable how long they can live without access to the air, notwithstanding the fact that, like the frogs, they can absorb sufficient air through their skins, and so remain beneath the surface for a long time, if the water be thoroughly aërated. I have never tried to drown a box-tortoise, but have found them dead in springs, into which they had fallen. Whether they died from suffocation or starvation could not be determined, but the fact that they are better lunged and thicker skinned would show that they could not be deprived of direct access to the atmosphere without fatal effect; but all the others, it would appear, being thinner skinned, could depend safely upon their power of skin respiration.

In the case of skin-respiration by the frog, Professor Semper has stated, in his volume entitled "Animal Life," that "Milne-Edwards the elder showed long since that frogs, when prevented from coming to the surface, were able to live under water so long as they were not cut off from the possibility of obtaining food, and were freely supplied with fresh water. In such a case general skin-respiration must necessarily take the place of lung-respiration." By experiment I have been able to determine that a snapper can remain twenty-one days beneath running water without food, and yet not appear to have suffered; although its appetite was perfectly wonderful when the creature was relieved from its confined and submerged quarters.

Considering, then, the facts, that one of these species has been known to take a baited hook in midwinter, and that individuals of this same or another species have been found to eat of fishes that were entangled in a net set beneath the ice, and bearing in mind that they have been found in quite an active state in shallow but open waters even in midwinter, it is safe to assert that certain of our turtles do not regularly hibernate from autumn until spring, as has been generally supposed; the snappers, the musk-turtles, and the "mud-diggers," furnishing the prominent exceptions to the rule.

CHAPTER XXX.

UZ GAUNT'S TALK ABOUT TURTLES.

"Christmas of '77 was a green one, you may remember," remarked Uz, as he shook the ashes from his pipe. "It didn't need any hickory logs blazin' on the hearth, such as these," and he stirred the ashes and rearranged the wood on the andirons as he spoke of them. "The weather had been mild for a long time, and once I heard frogs singin'. Well, this kind of thing sort of came to a focus on Christmas day, which was warm even in the shade. The river was low, the meadows dry, and the crows as noisy as in April. I felt sort of restless like, and took a walk in the meadows. I left my gun home, and thought I'd just look 'round. Without thinking of them when I started out, I wandered over to your marshy meadow, and began pokin' about with my cane for snappers. You know I take kindly to a bowl of snapper-soup of my own fixin'."

"Yes, I do that, and can run along neck-and-neck with you, when you're the cook."

"Well, I followed the main ditch down, jumpin' from hassock to hassock, and kept probin' in the mud with my cane, when, after a bit, I felt something hard at the end of my stick. It wasn't a stone or a stump, I knew at once. There was a little tremble run up the stick to my hand that told me that much. A sort of shake, as though you hit an empty barrel, as near as I can tell you. I'd a turtle down in the mud, and concluded to bring it out into the daylight. There's more than one way to do this, but none of 'em is an easy job to get through with. I kept probin' 'round him, to try and make out where his head was, and then I could feel for his tail, and pull him out. Now this does very well for one of your common snappers, but didn't work so easy in this case. I could sort of feel that turtle all over the meadow. Wherever I put my cane down, I seemed to come to his back shell; but after edgin' out a bit for some time I could make out the rim of it, and I tell you he was a whopper, accordin' to my probin'. That turtle seemed about as big 'round as a wash-tub, and I got regularly worked up about him. I wasn't in trim for huntin', but didn't care. I'd found a turtle that was worth havin', and I meant to have him. Probin' showed he was about three feet deep in the mud, but I made up my mind to locate his tail and then reach down for him. So I did, but it was no use. I felt about, and got one ugly scratch from a hind foot, but he kept his tail out of reach, or hadn't any; I didn't know which, then. After thinkin' a spell, I concluded I'd try to get a pry under him, and went for a fence-rail. It took me some time to get what I wanted, and when I got back that turtle had got out. I probed all 'round, but he'd moved. This rather took me down, but I kept up my hunt, and after a bit found he'd moved straight for the main ditch, and was tearin' up the mud on the bottom as he went. This was all that saved him for me, and I no sooner learned his whereabouts than I went for him in earnest. I ran the rail I had right under him, and tried to lift him up. Thunder and lightnin', boy, you might as well try to lift a steer. I disturbed him, though, and checked his course a bit. Jammin' the rail down again, I guess I hit his head, for it riled him, evidently, and he raised right up. His head and neck came up out of the sand, and I was for standin' back just then. If ever you saw a wicked eye, that turtle had one, and his head was as big as my fist. Stickin' his head out, though, gave me the knowledge I wanted. I knew how he laid in the mud, and I ran my rail down under him as far as I could. It kept him from divin' down, and I went right into the ditch to try and get a hold on his tail if I could. This I did, after feelin' for it a bit, and no sooner had I got a good grip on it than the old fellow got free of the rail and commenced goin' deep into the mud. I tugged and he dug, and it was a clear case of 'pull Dick, pull devil' between us. He was gettin' the better of me, though, for I was gettin' chilled in that water, and had nearly lost my hold, when the turtle gave an extra jerk, and if it hadn't been for the fence-rail I'd a lost him. I was pulled for'ard, but the rail was right in front, so I put one foot on it, to keep from sinkin' any deeper in the mire. This bracin' gave me the advantage now, and I put all my strength to it. The turtle came a little, and I seemed to gain strength. I tugged and tugged with all my might, and presently his hind feet showed. You see, he hadn't firm enough mud to hold on to. I backed slowly across the ditch when I got him in open water, and got a fair footin' on the ditch-bank at last. Still, I wasn't out of the woods by a long shot. That turtle weighed close onto seventy pounds, and I'd no means of handlin' him. Chilled through, with both hands needed to hold him, and in the middle of the mucky meadow, all that was left me was to try and drag him to the high, smooth meadows. It was a tough job, I tell you. I had to walk backward, and he pulled against me like a frightened horse. I gained a little, slowly, and after a bit got on the high ground. Then I felt more at ease and took a rest. I couldn't take him home, of course, in the same fashion, but I had a chance to let him loose, and rest my hands. How I looked 'round for a bit of rope to bridle him! It was no use, though, and after all I was likely to lose him altogether. After a minute's thinkin', it occurred to me I'd make a hobble out of my shirt and then slip home lively for the right sort of tackle. I wasn't long in gettin' the shirt off, and I twisted it into a sort of rope and hobbled him with it. It was a desperate, odd-lookin' turtle when I got through, and I laughed at him a bit as I turned toward the house. You see, I left him on his back, and his legs bound so he couldn't use 'em to turn over. I skipped pretty lively, I tell you, for that mile or so twixt me and home, and was in a good glow when I got in. Hettie looked kind o' scared when she saw me, but I put her mind to rest in two words, and soon was on my way back. A bit of rope and my sheath-knife was all I needed. I skipped over the fields pretty lively, and was soon again in sight. Now, I don't think it was an hour, by some minutes, before I was back on the high meadow, but, by gracious! it don't take long for scenes to change in natur' any more than it does in a theatre. Of all queer sights, that was the funniest I saw when I got back. The turtle had got half free of my old red shirt, and was pawin' the air like mad, tryin' to get on his feet again. I could see that much a long way off, and put on extra speed; but when I was about fifty yards off I stopped short. There was that turtle wrapped in my shirt, and a pesky skunk sort of standin' guard over him. Now, I hate skunks. They don't pay to trap, and they rob my hen-roost every winter. I was afraid to frighten him, too, for fear he'd spoil my snapper, and I wanted the value of a shirt out of the turtle, if nothin' more. I walked a bit nearer, to make sure of how matters stood, and it was clear as day, the skunk thought he had a good thing of it, if he could only kill that snapper. I thought the same way, and didn't want to be bettered by a pesky skunk. I made up my mind to jockey about it, a little; and so, first, heaved a stone at the critter. It gave me a look and started on a slow trot, but it was all up with me, sure enough. He shook that thunderin' old brush right at the turtle and—— well! if he didn't sicken the snapper, he did me, that's certain. I stood the racket a bit, though, and tried to move the snapper, but it was no use; I couldn't keep at it long enough to do anything, and don't believe it would have amounted to much anyhow. I got a stick and put the snapper on his feet, as well as I could, without touchin' him, and he waddled off for the mucky meadow, with most of my shirt still stickin' to him, and plunged into the ditch as soon as he could."

"So you lost the turtle after all," I remarked in a low tone, not feeling sure I had heard the last of the story.

"No I didn't either," Uz replied quickly. "Don't set me down for such a fool as that. I knew well enough the turtle wouldn't wander far, so I kept him in mind, and the next April I went out in proper trim and hunted him up. I found him after two days' huntin', when I got a dozen big ones besides, but he was the king of the lot. He couldn't turn 'round in a wash-tub, and weighed somethin' over seventy pounds. I looked all over him for some sign of my shirt, but there wasn't a thread left."

"How old do you suppose he was?" I asked, when Uz had concluded his story.

"I'm not sure I can say, but he was no chicken, that's certain."

"According to Professor Agassiz, a turtle a foot long is close to fifty years old," I replied.

"Fifty years old! Then my big snapper came out of the ark, I guess," remarked Uz.

CHAPTER XXXI.

SHORT STUDIES OF SNAKES.

Were this a fitting opportunity, I should be glad to give in detail the scores of marvelous snake-stories which from time to time have been related in my hearing, or which I have clipped from newspapers. These stories have not come solely from ignorant and superstitious people, but they have been told fully as often by those who were well informed on other subjects, and who would be considered people of average intelligence and education.

The prevalent absurd accounts of our common snakes show what an amount of ignorance prevails concerning a class of animals whose undoubted merits should be properly understood and appreciated.

My aim, therefore, in referring to them, is to break down, if possible, long-established prejudices. It is, perhaps, a hopeless task, a kicking against the pricks, but I shall not desist.

Unfortunately for the snakes, and for ourselves too, we grow up so imbued with unjust suspicions of all creeping things that, in later years, but few of us seem disposed to listen to the plain truth concerning the habits and capabilities of these most interesting and generally very useful animals.

Because one serpent is very dangerous, and capable of inflicting deadly wounds, it does not follow that all serpents are to be shunned. I certainly have no desire to encounter a tiger, but I do not therefore hesitate to play with a kitten; and yet the same style of reasoning which dooms the harmless snake would, if carried out, justify the indiscriminate slaughter of every animal of the cat kind.

In New Jersey we have two species of serpents—the rattlesnake and copper-head—the bite of either of which is usually regarded as fatal. These are found only in limited localities, and, even there, the danger to be apprehended from them is more apparent than real. As neither of them comes within the range of my rambles, there is no reason to fear them; so why should I dread the harmless serpents that may chance to cross my path? Rather, since they can do no harm, let me seek them out and strive to learn what they have to teach.

Of the nine or ten species of serpents that are found here, some are formidable in appearance and readily resent interference. What they do, however, is in self-defense, as they are never the attacking party. Of course, they will dart their pretty forked tongues; will hiss, and even snap at you; but there it ends. Their bite is less harmful than the sting of a mosquito, though the fact is by no means generally recognized and acted upon. What if a full-grown black-snake, when trod on, does wrap a coil or two about your legs? It can only result in injury to the snake, and all newspaper stories as to the serious harm they do to young children, by coiling about them, may be dismissed as fables. Perhaps a great part of the unjust suspicion that attaches to snakes may be ascribed to the stories of their fierceness related by early travelers. Thus, Campanius, in his "History of New Sweden," describes the rattlesnake as follows: "There is here, also, a large and horrible serpent which is called a *rattlesnake.* It has a head like that of a dog, and can bite off a man's leg as clear as if it had been hewn down with an axe." Such a description of any one of our serpents is enough to make a person timid and suspicious of all our snakes, nor can it be wondered at. Kalm, too, magnified the fierceness, size, and courage of our serpents, and particularly the black-snakes. Much of that which he relates, be it understood, never happened. Among other impossible occurrences he tells the following "snake-story," which it would be hard to match, even in these days: "During my stay in New York, Dr. Colden told me that, in the spring, 1748, he had several workmen at his country-seat, and among them one lately arrived from Europe, who of course knew very little of the qualities of the Black-Snake. The other workmen seeing a great Black-Snake . . . engaged the new comer to go and kill it, which he intended to do with a little stick. But on approaching the place . . . the male (snake) in great wrath leaves his pleasure to pursue the fellow with amazing swiftness; he little expected such courage in the snake, and flinging away his stick, began to run as fast as he was able. The snake pursued him, overtook him, and twisting several times round his feet, threw him down, and frightened him almost out of his senses; he could not get rid of the snake till he took a knife and cut it through in two or three places. The other workmen were rejoiced at this sight, and laughed at it, without offering to help their companion."

It will be observed that our author does not assert that all this happened within his personal knowledge, but, on the contrary, it is an instance of a person telling some one else what a third person saw; and this is usually the case with snake-stories.

Now, so far as the story of the fierceness of black-snakes being more marked in spring than at other times is concerned, the truth is, that this is the time of year when they are particularly sluggish. When disturbed in their dreams, on a bright spring morning, they will often remain rigid, and apparently feign death, rather than make an effort to escape or to simulate a courage which they do not possess, in order to frighten and drive you away. It is but fair, however, to our author to add that his own experience scarcely agreed with the stories that were told him, as will be seen by the following extract: "I can not well doubt of this—the fierceness of the black-snakes when mated—as I have heard it said by numbers of creditable people; but I could never succeed in provoking them. I ran always away on perceiving it, or flung something at it, and then took to my heels, but I could never bring the snakes to pursue me; I know not for what reason they shunned me, unless they took me for an awful seducer."

The reason is plain enough. Kalm desired to know the truth, and took the experimental way of learning it. His knowledge of the snakes was gained by familiar, out-of-doors intercourse with them, and it has stood the test of time. All that was needed, when he wrote, was the moral courage to say to the narrators of the marvelous stories, "You are mistaken"; or perhaps, more wisely, he might have kept silent. The most conscientious man, if afraid of snakes, can not tell the truth about them; and even in the case of the truly poisonous species, it is well to remember that "the devil is *not* so black as he is painted."

Although the rattlesnake does not now frequent this neighborhood, yet it was probably not uncommon here years ago. I have not, however, been able to find in any of the local histories any record of one having been seen here. Perhaps the black-snakes, which until recently were so numerous, succeeded in exterminating them, for the two are deadly enemies. That this might readily have been the case is very probable, particularly if such occurrences as the following were ever very common:

"In the middle of the road lay an ordinary black-snake and quite a large rattlesnake, eying one another fiercely, both ready for an attack. The party stood motionless to see the battle take place; but he waited long, and still the combatants did not move. At length, tired of watching, he slightly shook the bar of the fence, which caused the rattlesnake to look from its opponent to himself. Instantly, the black-snake sprang on the other, twisted itself tightly around its neck, and then its body, and glided off, and there lay the rattlesnake, dead. The victim, we all know, was a powerful foe, the victor as harmless a snake as there is in the land."

I have several clippings from newspapers, recording the capture of veritable copper-heads near here, but as the harmless hog-nose snake and the gentle calico-snake have often been mistaken for this venomous species, I am inclined to look upon all such reports as cases of mistaken identity. It would not please me to know that at any time I might possibly chance upon one, but as I never have in all these years been so unfortunate, I must continue to think that there is but little reason to fear them. Harmless snakes have repeatedly been brought to me as genuine copper-heads, and, to the horror of my friends, I have let these supposed dreaded serpents bite me, when I succeeded in provoking them sufficiently to do so; but even this proof of their harmlessness was not always satisfactory.

I purposely omit any discussion of the often-asked question, Do snakes swallow their young? I have never seen them do so, and here ends my knowledge of the matter. I have, therefore, only to add that as many snakes feed upon small snakes, and occasionally have two or three at once in their stomachs; and further, that as some species are ovoviviparous, or hatch their young within their bodies, thus offering, occasionally, the spectacle of a large female snake with twenty to thirty small snakes within it, it is possible that some such occurrence may have given rise to the stories we so often hear of snakes apparently swallowing their young in order to protect them from harm. It is thought not to be impossible, though improbable, that such a habit should be common to any species.

In the course of my rambles I have found a great many snakes, of all sizes, colors, and, I may add, dispositions. They are all well known to herpetologists, for a long and not always handsome name has been given to each variety. They are also well known in an anatomical point of view, though their habits, haunts, and merits have not been very closely studied. It would seem that, in most cases, to drop the squirming creature into alcohol, and tack a label on the bottle, was all that the naturalist desired to do. To know where a snake came from, and its scientific name, is, so far as it goes, very useful knowledge; but I would like to know what the snakes did before their capture.

Of the ten well-marked species that may be found within half a mile of my front door, probably the most abundant is the hog-nose snake, known to my neighbors by a variety of names, though none is so good as the one mentioned. "Adder," "flat-head," "viper," and a dozen other misnomers are freely used; "flat-head" being, perhaps, a fairly good name, as the habit indicated by this name is most marked in this species.

In the entire range of animal life I know of no creature so thoroughly harmless as this snake; yet, as it flattens its head, hisses loudly, springs menacingly, and snaps fiercely, it is credited by many with all the venom of the rattlesnake, which, by the way, it quite closely resembles in many ways.

As an object of study it presents much that is of peculiar interest. Without fangs, or even teeth of sufficient length to produce a wound beyond a mere pin-prick, it presents the outward appearance and has the pose and movement of the venomous serpents generally. Wholly unable to inflict the slightest injury, it has always puzzled me to understand why it should not, like all our other snakes, seek safety in flight. May we hold that it realizes the full meaning of the peculiar powers of the venomous serpent it mimics so admirably, and trusts to its being mistaken for a rattlesnake? Indeed, this mimicry has been perfect, in some instances that I have witnessed, inasmuch as the tail of the snake was rapidly vibrated against dead leaves, and so produced a sound that was strikingly similar to that of the rattlesnake. This similarity was, of course, accidental, as it was by mere chance that dry leaves were lying about; but at various other times I have noticed that the tail was held in the same position and vibrated in precisely the same manner as that of the rattlesnake. In these instances I thought I detected a faint whirring sound, or a buzzing, but on this point I am not positive.

Mimicry, on the part of snakes, is a ready way of explaining some of their habits; but even when accepted, it remains to be shown how it originated. Is there any evidence that in former times the hog-nose snake and rattlesnake were intimately associated? I can find none, and certainly at present the two species are not found together, not being frequenters of the same kind of localities. The hog-nose snake prefers open, sandy fields; the rattlesnake, rocks, and at all times a forest-growth, or, at least, a dense undergrowth. I have endeavored in vain to detect something in their habits, haunts, and anatomy that could throw light upon these questions, but, as yet, all in vain; I can only say that the snake is in appearance a rattler, but that it has neither the rattles nor the fangs. A veritable impostor is he, sailing under false colors throughout his whole life.

Of all our serpents, the hog-nose is, by far, the most sluggish in its movements. So slow is it, that it can be easily overtaken, if it should attempt to escape, which it rarely does. I have found them partial to loose, sandy soils, as in cultivated fields, in which they burrow with all the facility of a mole. They burrow, I am led to believe, only to a shallow depth, and think it is in search of earth worms and insect larvæ, and not merely for the sake of shelter. In several instances, where I have detected them coming out of the ground, I have found in their stomachs masses of semi-digested animal matter which were believed to be the remains of earth-worms and insect larvæ. This fact should give the snake a claim to protection from the farmer, and this is now set up for them, though with little or no hope that my interposition in their behalf will result in any permanent benefit.

In the month of May I have frequently found their eggs, in considerable numbers, a few inches below the surface; and early in July I once found a family of seventeen very small and apparently just hatched young. In this instance no old snakes were seen. Young as these little ones were, and apparently with quite defective vision, they resented all interference, and snapped and hissed precisely as an older snake would do. Even the head and neck were distinctly flattened.

While sensitive, as all snakes are, to cold, these hog-nose serpents appear to have greater powers of endurance than any of the other species that are found in this vicinity. They are, I think, the first to make their appearance in spring, and the latest to go into winter-quarters. These quarters are usually burrows of such depth and in such a position as to be beyond the reach of frost, and in them many individuals are congregated. Occasionally different species of snakes are associated in these subterranean retreats, three or four being often coiled together in an almost globular mass. At such times they are quite inert, and do not revive until exposed to a considerable warmth for several hours.

An uncommon variety of this species of snake is nearly or quite black, and, being somewhat more vicious in appearance, it has the reputation of being even more dangerous than its mottled black and yellow companions. All the black specimens that I have seen have been very large, and otherwise seemed to be old, and it is my belief that they are merely aged individuals, and not a variety or sub-species.

Kalm says of the serpents found in New Jersey: "The Rattle-snake, Horned Snakes, red-bellied, green, and other poisonous Snakes, against whose bites there is frequently no remedy, are in great plenty here." This statement is worthy of a moment's consideration. It is correct so far as the poisonous character of the rattlesnake's bite is concerned; but what of the other species he mentions? Possibly his "horned snake" is the hog-nosed serpent about which I have been writing; or, if not, it may be the mythical hoop-snake to which he refers—a snake that hundreds of people are ever ready to affirm they have occasionally seen, and by which they have been chased; but which, strangely enough, has never fallen into the hands of a naturalist. The "red-bellied" snake mentioned by Kalm may be any one of three or more species that have a red or ruddy belly. I suppose, however, that he refers to our common water-snake, a species that has afforded me much entertainment while watching it in its chosen haunts.

Kalm, it will be noticed, believed it to be a poisonous species. This, of course, arose from simple hearsay, as he evidently was too prudent to test the matter personally. Even at present it is generally supposed to be venomous, although its harmless nature has been noted by every herpetologist. If facts of this character, embodying as they do much useful knowledge, were taught in our public schools, as they ought to be, we should be spared much nonsense. Only the other day I read in a local newspaper that "a large, poisonous water-adder, measuring over seven feet, was killed near the mill-pond. It is supposed to have bitten several cows." Here are two errors, to call them by no harsher name, to start with. In the first place, the snake is not poisonous; and in the second, no one of them ever grew to be seven feet in length. As to biting the cows, that is not improbable; but the wounds inflicted were not so serious as the bites of the blood-thirsty green flies that worry our horses and cattle throughout the summer months.

The common water-snake is strictly an aquatic species; not that it can not and does not freely leave the water, for this it frequently does, though the shallow, weedy brooks, the deep mill-ponds, and even the river itself, are, essentially, its homes. In such localities, it is the active, alert, lithesome serpent that I never tire of watching.

These snakes, if not venomous, are vicious, I admit, and do not hesitate to bite, if irritated; but the result is like the prick of a pin. I have often teased them, to see how hard they could bite, and found that they seldom brought blood, and their teeth never remained in the skin of my arm or leg.

I have noticed that the water-snake, in this neighborhood, is partial to still waters of considerable depth, and seldom frequents streams that have not a bottom of deep, soft mud, in which to take refuge when pursued, and in which it buries itself deeply during the winter. While fond of sunning itself on the banks of streams, it also spends much time *on* the mud. Occasionally, when cautiously approached, it will move off in such a gentle manner as to leave the imprint of its body on the muddy bed where it had been resting. Unlike all others of our snakes, this one does not require constant access to the atmosphere, but can live for days in well-aërated water, as I have determined by repeated experiments.

While, usually, the water-snake, in passing from the land to the water, simply glides from the shore to its proper home directly, I have found that, at times, it would pass through burrowings near the shore, and seek the water by a short subterranean passage. Such burrowings or passages are not made by the snake, I am positive, but are the work of star-nosed moles, shrews, and, in some cases, of cray-fish. That such routes should be chosen by the snakes is not readily explained, for I find that the snakes do not linger in them, but pass directly through and into the mud beneath. To be sure, if the creature is escaping from an enemy, real or supposed, this means is more effectual than a direct plunge into the water, as the snake reaches the bed of the stream, and is wholly out of sight, beneath the mud. But is a water-snake sufficiently intelligent to warrant us in accepting this as an explanation? During the summer this snake delights in sunning itself on a mat of dead grass, which it appears to collect for the purpose of making a more comfortable bed than the growing grass alone would afford. Often, well coated with mud, they crawl from the bed of the stream to these spots, and there remain a long while, tightly coiled and, I suppose, asleep. The adhering mud, now exposed to the sun, quickly dries and falls off, and in time the grass beds become completely covered with a fine dust, often an inch or more in depth.

At other times these snakes, well coated with mud, go directly from the water to one of the subterranean passages, and, passing down the narrow entrance, they leave a portion of the adherent mud as a rim about the opening. When sun-dried, such ring-like elevations closely resemble the curious "mud chimneys" of the cray-fish; and the latter, by many people, are considered as the work of water-snakes. Time and again I have been told that the cray-fishes' mud-works were "snake-holes," and I am not surprised that such an impression is common, for it must be remembered that water-snakes do occasionally make a similar ring of mud about holes in the mud-banks of creeks and ditches; and again, who has ever seen a cray-fish building his "chimney," ring after ring, until it reaches several inches in height?

In the water the movements of this snake are as agile as those of the most active fish, and their food consists very largely of minnows. These they catch by a sudden dart through a school of them, seldom failing to seize one of the number. It has seemed to me, however, that this was rather a hap-hazard proceeding, as the snake did not appear to single out any particular fish, but merely opened its mouth and left the rest to luck. Often fishes of a large size are seized in this manner and dragged to the shore, when, after dying from exposure to the atmosphere, they are again taken to the water, buried in the mud, and devoured by the snake at its leisure. Frogs, too, form a not inconsiderable part of their food, which I am inclined to think is sought as well on land as in the water, though I have never found them so engaged. Nor have I ever discovered any evidence that they preyed upon mice—the principal food of land-snakes—in the many dissections that I have made.

There is another species of water-snake which I have occasionally seen in our creeks and ditches—seen it swimming by, and that is all.

Occasionally, late in April and throughout the month of May, several small species of snakes (collectively called "garter-snakes" by the country people) may be seen in the shallow waters of our ditches. There is a family likeness running through the series, and it is often difficult to identify them. One of the prettiest and most active of these is called De Kay's little brown snake. It is fully as active as the foregoing when in the water, and far more agile and rapid in its movements when on land. My last opportunity of observing them was in May, 1881, when I found three of them on the bank of a shallow ditch, each occupied in slowly swallowing a little frog or "peeper." Frequent observations, made some years ago, convince me that the several species of grasshoppers constitute their principal food-supply in summer.

Like the true water-snakes, they are excellent fishers, and, gliding through the shallow waters with marvelous celerity, they catch minnows and young pike in large numbers. Late in the summer I find that they retire to the upland woods, where they are often seen in sunny nooks, coiled up on beds of dry, dead leaves; and throughout September and later I have seldom found them in the ditches and surrounding meadows, which seem to be their haunts in spring and early summer.

This little brown snake is readily tamed, and can be taught to take flies from the fingers. Indeed, I think they recognize those who are accustomed to feed or handle them.

Another snake, perhaps less common than the foregoing, but more conspicuous from its greater size and brilliant markings, is the ribbon-snake, or "swift garter." Of all our serpents, this is my favorite. For hours I have played with them, and never knew one to exhibit any ill-temper, even when teased persistently. While perfectly at home in the water, this serpent can not be considered as aquatic or even semi-aquatic. Far more frequently I have found them in the high and dry woods, not always creeping or darting over the dead leaves, but in trees and bushes, several feet from the ground, where they seem to be quite at home, twisting and turning amid the tangled branches of the stunted oaks as freely as if on smooth ground. Just what they were seeking in such situations I could never determine, for I never saw them robbing birds' nests nor peering into squirrels' homes in the hollow trees. Tree-toads, I know, they occasionally capture, but these are not sufficiently abundant to induce a snake to spend much time in hunting for them.

It is eminently true of this snake, and I believe it is equally so of all our smaller snakes, that they prey very largely upon insects. I do not suppose that the aggregate of insect-life thus destroyed is very large, for these animals, as a class, are not voracious feeders. Very often a mouse serves them as a meal, and satisfies their hunger for a week or more. It is probable, however, that the number of mice and young squirrels destroyed by snakes would be much greater if there were no insects for them to feed upon. The larger grasshoppers, black crickets, and even beetles, I have often found in the stomachs of all our smaller upland snakes.

Another very common species is the true garter-snake. In the course of a summer more of these garter-snakes are seen than of individuals of all our other species together. This arises from the fact, in part, that they are a social snake, and a dozen or more will often wander about a chosen haunt in company. I never find one but I instinctively look about for its companions. They are quite cunning, and, when hard pressed, exhibit considerable ingenuity in their efforts to escape. They are also, at times, very irritable, and when cornered they often show fight as promptly as the hog-nose snakes. They can inflate their bodies, slightly elevate the scales on their backs, and thus present a somewhat formidable appearance. Their needle-like teeth are also brought into play, and with a great show of courage they bite viciously and even hold on with some persistence. There, however, it ends.

The eggs of this garter-snake, as well as those of the preceding, are deposited in the loose, sandy soil of the recently-plowed fields. I have found none earlier than May 9th, and once on July 13th I found a complement of seventeen, within a day or two of hatching. In every instance they were in fields newly plowed and free of all vegetation. The depth at which they were placed varied from three to seven inches.

It is not a little curious that, considering the large numbers of eggs that are to be found in the earlier part of summer, so few very small snakes are to be seen. I have never come across one less than four inches in length, except in the cases of the brood of hog-nose snakes mentioned above, and of those which I have ushered into day by unceremoniously breaking the egg before the occupants were quite ready to emerge.

Even larger snakes, those measuring from six to ten inches in length, are by no means common. This may be due to the fact that they are surrounded by enemies which make sad havoc with their numbers, or possibly some of our smaller mammals may feast upon the eggs. Precisely what these enemies are I can not determine, though I am sure of their existence. More than once I have seen skunks rooting in newly-plowed ground, and at the time it occurred to me that they were probably searching for turtles' or snakes' eggs. Those of the turtle would largely escape detection, if an animal searching for them were guided by scent alone, as they are more deeply buried, and, except by the snappers, care is taken in obliterating all trace of the locality. In the case of the snakes, however, no such care is exercised; and their eggs are buried in such a shiftless manner that a hard rain often exposes them to full view.

While it sometimes happens, in early spring, that snakes are met with in such numbers and so closely associated as to appear as one object with innumerable heads, I have never seen anything similar to the bundles or balls of snakes mentioned by some observers. True, I once saw what I believe to have been fully fifty snakes, lying "all in a heap," but when I approached them, the individuality of each became apparent, as they scampered off in every direction, regardless of their neighbors' movements. A veritable bundle of snakes has been described in the "American Naturalist" for March, 1880, as follows: "The statements made by Humboldt, as to the piles of snakes he saw in Guiana, can be verified here in our Northern woods and swamps. I personally had the pleasure of observing it twice, both times very early in spring, and in localities which could be called wilderness. I first saw such a bundle of snakes in the neighborhood of Ilchester, Howard County, Maryland, on the stony bank of the Patapsco River, heaped together on a rock and between big stones. It was a very warm and sunny location, where a human being would scarcely disturb them. I reasoned that the warmth and silence of that secluded place brought them together. Some hundreds of them could be counted, and all of them I found in a lively state of humor, hissing at me with threatening glances, with combined forces, and with such a persistency that stones thrown upon them could not stop them, nor alter the position of a single animal. They would make the proper movements and the stone would roll off. All the snakes in this lump were common (garter) snakes. . . . The second time I noticed a ball of black-snakes rolling slowly down a steep and stony hill-side on the bank of the same river."

Although so much was said of the black-snake, when speaking of serpents as a class, there are yet points in its habits that deserve attention. Perhaps no one of our serpents is more thoroughly dreaded, and with less reason. It is harmless in every sense of the term, and yet in spite of this fact, and of the benefits which it confers upon the farmer, these most useful serpents are becoming yearly less numerous.

Perhaps the most interesting feature in the history of the black-snake is the power of "charming" a bird or small mammal, which it is supposed to possess. This act is said to consist in exerting, by mere glance of the eye, such influence over the bird or mammal as ultimately to deprive it of all power of locomotion. I must confess that I am somewhat skeptical on this point, although I have on several occasions witnessed cases of such "charming," i. e., cases where small birds were literally frightened to death by the snakes. On careful examination, however, I found that the snake was suspiciously near the nest of the victim. The bird evidently experienced a struggle between the impulse to defend its nest and the desire to escape a dreaded foe; and this is, I think, the explanation of its short flights and quick returns, as though held by a short string. A victim to these opposing emotions, the bird finally became exhausted and fell to the ground within reach of the snake. Once I caught such an exhausted bird and found that it was simply worn out. After a half hour's rest, it flew away without so much as saying "thank you." Further, I believe this "charming" can only occur among some of our timid birds, like the chipping-sparrow, summer-warbler, and others. The biggest black-snake that ever crawled could no more scare a common wren, than could a frog in a spring "charm" you. Detailed accounts of such things have, I know, been frequently published, and no doubt they were thought to be true; but in the cases witnessed by me, a much simpler explanation can be found in the fact that the snake, instead of exerting any occult power, simply devoured the exhausted bird that came within its reach.

Kalm gives a detailed account of the fascination exercised by the rattlesnake over squirrels, and incidentally tells us that the same power is possessed by the black-snake. The translator of the volumes, however, sees nothing remarkable about the habit, and suggests a very reasonable explanation of the fact.

Perhaps snakes do charm birds, as is popularly supposed—but I don't believe it!

Thus far, I have never been able to determine the maximum length to which a black-snake may grow. Years ago, I started a discussion upon this point in a weekly paper, but soon had occasion to regret my temerity. The stories that were told were beyond the limits of all possibility, and, though gravely assured that black-snakes ten feet long had not only been killed but actually measured, I am free to confess that I don't believe it!

In regard to the length of snakes generally, it is safe to say that, with timid people, a great deal depends upon the direction in which the snake was moving at the time it was seen. As my observing old friend Uz Gaunt once said to me, "When snakes come towards folks, every foot looks a yard long."

Within the bounds of my usual rambles I have never but the once chanced upon that exquisite creature, the green or summer snake. The locality is not, I suppose, to their liking, though I sincerely wish that it was.

The one specimen that I saw was captured and kept alive for several months. It became very tame, and evidently recognized me. Although allowed considerable liberty, it did not seem to be very active during the day, but was restless in the evening. It seemed to be more sensitive to cold than any other of our snakes, and remained under its little blanket when the day was rainy, or a strong east wind prevailed. It fed upon flies, which it would take from my hand, seizing them very leisurely, and swallowing them deliberately. There was nothing of the snap and gulp of a salamander or toad about the process. When, however, the snake went fly-hunting on its own account, there was a very different state of affairs. There was still great deliberation, but only until the moment for action arrived, and then with a snap the fly was gone.

Occasionally this pet snake would creep among a number of pots of flowers, and coil about the green branches. At such times, it would frequently extend some three or four inches of its body outward and beyond any support, and thus remain as rigid and apparently lifeless as a twig. This, probably, was a habit common to the snake when free, but why it should be indulged in under such changed surroundings I can not imagine. Certainly, it was not for the sake of seizing its food, for I noticed that the snake would assume this position after a hearty meal, and it did not ordinarily assume it when asleep. In its proper home, such a habit on the part of a small snake of this color would render it, for the time, very secure against such enemies as were guided only by sight. Even when standing very near the rose-bush upon which my pet rested, I found it, when in this position, a very inconspicuous object.

A very common species, and one that is found over the whole United States, east of the Mississippi River, is the handsome ring-snake. In my immediate neighborhood, however, they are not often seen. This, I believe, arises more from the care with which they conceal themselves than from their scarcity. Being naturally very timid, they are ever on the alert, and, hearing an approaching footstep long before there is any chance of seeing them, they scuttle away and burrow beneath the dead leaves, or seek a hidden recess in some half-rotten log. A favorite locality with them is beneath the loose bark of a fallen tree. Here they not only find shelter, but an abundance of food, as they feed largely upon insect larvæ and the pupæ of the large black ants that have their nests in rotten wood.

When captured they offer no resistance, and become apparently reconciled at once to their loss of freedom. They are not of a mild disposition, but quite the contrary, when placed in limited quarters with other snakes. Weak and timid as they are, their distaste for such company rouses in them all the energy they possess, and without hesitation they try to drive off the intruders, even if twice their size and strength. At such times, too, the peculiar, pungent odor belonging to them is particularly noticeable, and I have thought that probably this disagreeable scent was exceedingly offensive to other snakes, and was therefore one of the means of defense that they possess.

The actions of the ring-snake, when placed with other species, has further led me to believe that, notwithstanding their offensive smell, the larger snakes occasionally attack and devour these little fellows; but I have never been fortunate enough to prove this by witnessing an attack on the part of a large snake, nor have I ever found the remains of this snake in the stomach of another.

Another one of our snakes which, from its large size and brilliant markings, is a most attractive feature of dry, upland woods, is the spotted adder, which has been given, strangely enough, the unusual name of "thunder-and-lightning snake." Beyond darting its forked tongue, it never even offers to resent molestation, except under certain circumstances to which reference will shortly be made.

A few words in regard to serpents' tongues. They are narrow, cylindrical, and forked. When the snake is at all disturbed, the tongue is darted out with great rapidity, and this gives the animal a threatening appearance.

There the matter ends. The tongue, of itself, is as harmless as so much thistle-down, and the creature uses it principally, if not wholly, in feeling its way along; for a snake's eyes are so placed that it can not see directly in front of it. Notwithstanding this fact, I find the impression common, even among educated people, that the tongue of a snake is a veritable sting, and as certain to produce a wound as that of a hornet or bee. And recently a natural history society listened without protest to an effort of a herpetologist (?) to show that the tongue of a snake was used for charming its prey.

To return to the spotted adder. This snake, when found in the woods coiled upon a heap of dead leaves, will often closely imitate the peculiar rattle of the rattlesnake, by vibrating the tail with great rapidity, and in such a manner as to strike the leaves beneath it. I have already called attention to this mimicry of the rattlesnake on the part of the hog-nose snake. There it was, I thought, a case of accidental imitation, the leaves beneath the snake being unintentionally struck by the vibrating tail. However this may be, my impression of this act on the part of the spotted adder is that the noise is produced intentionally. Of course, I do not mean to say that it is so far intentional as to be a studied imitation of the sound made by the rattlesnake, that being a point that can not be ascertained, and it would be crediting them with too great a degree of intelligence to assume that they studied the habits of their fellow-serpents and profited by them.

The last spotted adder that I had the pleasure of finding vibrated the tail in a very marked manner. When first seen, the snake was lying on a thick bed of dead oak-leaves in the woods. It was closely coiled, and, when disturbed, raised its head, hissed, darted its tongue, and at the same time vibrated the tail very rapidly and in such a manner that it gently struck the dead leaves as it moved up and down. The motion was distinctly up and down, and not sideways, as in the case of the hog-nose snake. The sound produced was exactly like that of a medium-sized rattlesnake. On removing the snake to a spot near by, where there was only grass, I found that the movement of the tail was not repeated, although some time elapsed before I teased it. After several efforts I replaced the snake among the leaves and allowed it to remain for more than an hour. It made no effort to escape, and, when I returned suddenly, it quickly coiled itself as before, repeated the vibratory movement of the tail, and produced the same rattling sound as before. This can scarcely be considered as positive evidence; but my impression then was, and still is, that the snake depended upon the dead leaves to produce the rattling sound, and trusted to the sound to frighten its tormentor. As we naturally associate this sound with the similar but very significant rattle of the rattlesnake, are the two species in any manner connected?

A similar occurrence to that mentioned above has been described in the "American Naturalist," September, 1879, and the writer asks: "Is this to be called an example of 'mimicry'? May it be said that, far back in the past, some sagacious ancestor, witnessing that act of intimidation on the part of a rattlesnake, and observing how successful it was, resolved to adopt the practice itself, and thus, through inheritance, the practice became ingrafted upon this species?"

It has not, so far as I am aware, been shown that the sound produced by the vibration of the tail does produce a feeling of terror in the breast of any creature, whether it is attacking the snake or attacked by it. If it be true that snakes overcome their prey by rendering them powerless through fear, then any sound that is peculiar to snakes would, when heard, frighten the animal, but only to such a degree as to put it on guard; and such a sound would prove detrimental to the snake's welfare. Even in the case of the rattlesnake, it does not add to the horror that its appearance produces. We are quite in the dark as to the reason why these sounds are made; but that reason, be it what it may, is quite probably the same, whether made by the rattlesnakes with their peculiar apparatus, or by the simpler method adopted by the spotted adder. Certainly, so far as man is concerned, this sound is an almost certain means of causing the snake's death. Had it kept quiet it might have escaped observation; but in thus giving notice of its whereabouts it signed its own death-warrant. This has so long been the case, that if the harmless spotted adder had possessed sufficient intelligence to see the advantage of the rattle to the rattlesnake, and had been determined to imitate it, as well as it could, it should also have learned that this same sound, when made within the hearing of some of its enemies, would endanger its safety, if not work its destruction.

One other thought arises in this connection. In the case of the rattlesnake, admitting that the rattles have been evolved when the environment was wholly different, may it not be that the peculiarity is now retained, albeit no longer useful; while with such harmless species as the hog-nose snake and spotted adder, it is quite probable that the element of fear on the part of the snake plays an important part, and that this "rattling" is a result of fright on their part, rather than a desire to excite a similar feeling in their enemies?

There is yet another snake, occasionally met with in this neighborhood, known by a score of unmeaning names, not one of which is characteristic. De Kay, in the "Natural History of New York," calls it the "red-snake," and Jordan, in his "Manual of Vertebrates," "ground-snake."

It is not, strictly speaking, a red snake, neither is it even always of a reddish color, nor does it cling more closely to the ground than most of those other serpents that have been mentioned. By many it is called the "blind snake," because of the small size of its head, and, in fact, the head and tail are so similar in size and shape that this name is fully as descriptive as either of the others.

The few specimens that I have seen have varied in color from a blue-gray to a reddish brown; but whatever may be the color, it is uniform, and this, together with its small size and the absence of everything like stripes or spots, at once decides the identity of the species.

I have been accustomed, in my field-notes, to call this little serpent the "cricket-snake," from the fact that I have twice found specimens with crickets in their mouths. One of these specimens was of a decided blue color, and the other a very pale brown, or clay color. I associated the color with the surroundings, and have since wondered whether or not, like the tree-toad, it might not vary in this respect with the character of the locality it chanced to occupy. It is scarcely necessary to add that it is quite harmless, and offers no resistance when handled. In its general habits it presents no striking peculiarities.

So much for the eleven species of snakes that I have mentioned. Twenty years of familiarity should have yielded better results, but it has not.

CHAPTER XXXII.

UZ GAUNT'S SNAKE-STORY.

"WELL, as a sort of a text to my discourse, let me say, when a snake's runnin' away from you, you can measure it by inches; but when it's comin' after you, every inch is a foot long. That's how one feels about it.

"Now, when the June fresh' was over the meadows, and everything that wasn't a fish was afloat, I was busy after ducks and anything else worth shootin'. Well, one morning, as I was floatin' about, seein' more curious objects at a glance than I ever did before or since, my eyes rested on a big water-snake lyin' full stretch on a fence-rail. He was a whopper, now, I tell you. The rail was eleven foot long—I measured it—and the head of the snake was at one end, and the tail mighty close to the other."

"Are you sure of that, Uz?" I asked doubtingly.

"Don't interrupt, boy; that's the easiest part of it," Uz continued. "Well, I wanted the skin of that snake, just to show folks; so I blazed away. I aimed at the middle of the snake, and no sooner than I'd pulled trigger, when all of a sudden about a hundred snakes raised up on that rail and seemed to make for me. I came near upsettin' the boat, I was so taken aback. What I'd seen wasn't one big snake at all, but a whole swad of 'em, and they had just twisted 'round each other like strands of a rope, and lay there, baskin' in the sun, on that fence-rail. So soon as I had taken it all in, I laughed right out, and wasn't scared a bit then; but, boy, I wasn't out of the woods by a long shot. Now here comes the toughest yarn you ever heard from me, at least you'll think it a yarn."

"Indeed, I will not," I said very earnestly.

"You say so now; but never mind, and let me have all the say for a while," Uz continued, and I acquiesced by a nod of the head.

"Well, I was gazin' 'round at the snakes that were swimming all about, and some of 'em were climbin' back on the fence-rail. There were lots of 'em, big and little, and every sort I ever saw about here, I believe. Not wantin' any, I turned off, and sculled toward Swan Island floodgates. I found there was a big hollow buttonwood lodged right across the gates. I sculled up close to it, expectin' to see somethin' in or about it, for everything afloat then, you know, had its living freight. I held my gun ready, thinkin' there might be a mink or otter around: when, just as I was scrapin' against the tree, down rattled a whoppin' big snake into the boat, and another followin', and another and another after them, for all I know. I pushed off, quick as I could, but was kind o' tangled in among the branches at the time, and, before I got clear, there were three thunderin' big snakes coiled up in the bottom of my canoe. I eyed 'em pretty close, and didn't recognize 'em. They had the look of the common puff-adder, or "hog-nose," as you call 'em, but didn't look the same. They were most too big, and seemed to be spotted in a different way. Perhaps they were all right and harmless, but I didn't like their looks. In a minute I made up my mind to get rid of 'em if I could, and lifted my scull out of the water. One of 'em, coiled up nearest to me, raised his head, as I did this, and set his tail a-buzzin' like mad. I heard the sound, clear and clean, and saw that the critter was a rattlesnake. I gave one look at the other two, and they was the same. There I sat, in the stern of the little boat, with three rattlesnakes eyin' me, and not one of 'em six feet off. I don't quite remember just what I did, but somehow without accident I got the scull back, and started on. Either the near snake by his looks told me, or something else did, that if I put for dry land they wouldn't make trouble. Now it's a good half mile to the hill-side from the Swan Island gates, and I took a straight course, I tell you. Big fool that I was for bein' so frightened; I didn't keep much of a look ahead, and, 'fore I knew it, I went bump into a big saw-log that had come down the river. The boat came to with a jerk, and up raised every one of them snakes fully a foot or more, and didn't say anything, but looked at me, as much as to say, 'Do that again, Uz Gaunt, and your goose is cooked.' I hadn't control of my scull as I generally have, but somehow I made out to get movin' again. Luck was against me somehow, and I got into a tangle of grass and brush, but didn't come to a stand-still. One of the snakes, though, didn't like the sound of the boat's bottom gratin' over the brush, so it raised up, and coiled on a box that was lyin' at my feet. He settled on that box, with one lap of his coils restin' on the toe of my boot. I didn't dare to stir. All of a sudden that foot began to tickle like, and I wanted to wiggle my toes, but I didn't dare to. Then that leg got to sleep, and I couldn't shift it. It hadn't any feelin' in it, and I felt as though I'd tumble over on one side. It was no use. There was that one snake, on guard like, and it was evident to stir was certain death. The boat didn't seem to move ahead worth a cent; I kept my scull goin', but it didn't send the boat spinnin' along as I've often done when chasin' a wounded duck. But I did come up to the shore in time, right close by the Pearson house on the hill-top, and somehow everything came to me all of a sudden as the boat grated on the sand. I gave a jump, clearin' the length of the boat, and made for the hill-top. 'Uz, you're a fool,' I said to myself before I'd taken many steps, and came to a stop. There I was, free as air, yet runnin' as though the snakes was after me. Soberin' down a bit, I walked back toward the boat, and peered 'round very careful, I tell you. There was no sign of the snakes on land, and I went close up to the boat. There the three vermin were, sure enough. I didn't know just what to do. I'd left my gun in the boat, besides, forgettin' all about it in my hurry; besides, I couldn't have shot anyhow without hurtin' the boat, and it was my new cedar skiff. Thinkin' a minute, I cut a stout saplin', and, getting near enough, I gave one of 'em a pat on the head, and straightened him out, and then tackled t'other two. They didn't show any fight, and I got through all right, and, gettin' in my boat again, I pitched 'em out on the sand. Somehow they'd a sort of natural look, now they were dead, and, lookin' closer, hang me if every snake's tail wasn't as smooth as a whip-lash! Oh! but I was mad. To think of bein' scared out of my wits by next to nothin', for every one was a harmless adder. From then till now I've hated snakes, and always shall."

I laughed at his story, and he joined me, so far as to smile, for Uz never laughed aloud, I believe.

"I never supposed you saw anything that far wrong, Uz," I remarked, after a pause.

"I don't often, I believe; but when it comes to snakes, I'm sure of nothin'. It's with me, when I see snakes, as with many people who see commoner sights. I jumped at a conclusion, and conceited I never could jump in a wrong direction. Fact is, you've got to stop a bit and consider, whatever you do. With most of us it's a good deal like walkin' over Watson's meadows. Often greener grass grows on quicksand than the stiff dirt; but it don't do to walk on it, nevertheless."

CHAPTER XXXIII.

SHORT STUDIES OF BATRACHIANS.

It is with some hesitation that I venture to utilize the few notes that I have made upon the habits of the many batrachians common to central New Jersey. So promising a field is here offered, that I feel ashamed at not having long since availed myself of the opportunity of studying this class of animals, in spite of the difficulty which is often experienced of observing them to advantage when in their chosen haunts. A salamander, for instance, will remain absolutely motionless for an hour on or under some dead leaf, in the trickling waters that wend their way riverward from a mossy spring. To sit or stand for an hour, and watch this immovable creature, is both painful and monotonous, and when, at last, you disturb it, perhaps accidentally, away it goes to some similar spot near by, and resumes its motionless attitude. To spend more time, perhaps plagued the while with suspicions of possible rheumatism, and serenaded by mosquitoes, is scarcely practicable, and studies of salamander life soon become a bore. That their whole time is not spent in lying still, or in creeping in the mud, is the one fact about which I am certain; and however discouraging this result may be, it is possible that some future observer may have better luck.

The toads and frogs are more easily observed, and their habits have been so closely studied that there are few people who are not familiar with the prominent points of their life-histories. This, however, need not deter us from studying them, as probably not one half the whole truth is yet known; and, besides, there are many prevalent errors to be corrected.

Referring to frogs, I recall the words of Peter Kalm, when he visited this neighborhood. One hundred and thirty-two years ago, yesterday (May 31st), he records that "toward night, after the tide had begun to ebb, and the wind was quite subsided, we could not proceed, but dropped our anchor about seven miles from Trenton, and passed the night there. The woods were full of fire-flies (*Lampyris*), which flew like sparks of fire between the trees, and sometimes across the river. In the marshes the bullfrogs now and then began their hideous roaring, and more than a hundred of them roared together. The whip-poor-will was likewise heard everywhere." While I am writing I glance from my paper, through the study-window, and I see the very spot where Kalm tarried on that summer night. The same marshes are there, and remains of the forest; and on any pleasant summer night we may still see myriads of fire-flies, and hear the "hideous roaring" of the frogs, and scarcely less monotonous call of the whippoorwill.

Let us now consider these various frogs and salamanders *seriatim*.

Perhaps the most common of all our frogs is that of which Kalm has given a very good description in his "Travels in North America." Speaking of it, he says: "*Rana ocellata* are a kind of frogs here (New Jersey), which the Swedes call *sill-hoppe tosser*, i. e., herring-hoppers, and which now (March) began to quack in the evening and at night, in swamps, pools, and ponds. The name which the Swedes give them is derived from their beginning to make their noise in spring, at the same time when the people here go catching what are called herrings, which, however, differ greatly from the true European herrings. These frogs have a peculiar note, which is not like that of our European frogs, but rather corresponds with the chirping of some large birds, and can nearly be expressed by *pi-cet* (pēē-seét). With this noise they continue throughout a great part of spring, beginning their noise soon after sun-setting and finishing it just before sun-rising. The sound was sharp, but yet so loud that it could be heard at a great distance. When they expected rain they cried much worse than commonly, and began in the middle of the day or when it grew cloudy, and the rain came usually six hours after. As it snowed on the 16th of the next month (April), and blew very violently all day, there was not the least sign of them at night, and during the whole time that it was cold, and while the snow was on the fields, the frost had so silenced them, that we could not hear one; but, as soon as the mild weather returned, they began their noise again. They were very timorous, and it was difficult to catch them, for as soon as a person approached the place where they lived, they are quite silent, and none of them appeared. It seems that they hide themselves entirely under water, except the tip of the snout, when they cry; for, when I stepped to the pond where they were in, I could not observe a single one hopping into the water. I could not see any of them before I had emptied a whole pool where they lodged in. Their color is a dirty green, variegated with spots of brown. When they are touched, they make a noise and moan; they then sometimes assume a form as if they had blown up the hind part of the back, so that it makes a high elevation; and then they do not stir, though touched."

This "herring-frog," as it is usually called, is, I believe, the first to "give tongue" on the return of spring. Hibernation with them is, at best, an uncertain and impatient sleep; and even as early as the middle of February, if there be a few consecutive warm days, they will commence what is complimentarily called, nowadays, their song.

There is a saying common among my neighbors that these herring-frogs must be "shut up" three times by frost before spring fairly opens. I made a note of this years ago, and subsequent observation has shown that it would be nearer right to say "three times three" times.

The eggs of this frog are deposited on the margins of quiet waters, and adhere loosely to twigs and dead grass. In a short time (I am not sure just how many days, but think it varies with the temperature considerably) the eggs are hatched, and then the waters become fairly alive with diminutive tadpoles.

By this time these herring-frogs have become comparatively silent, and are careless of the welfare of their young. They leave the water for much of the time, though they never wander far from it. In the tall grass that grows along the banks of every pool they forage for flies; and they seem to live without any ambition, save that of supplying their daily wants and guarding against the approach of snakes, by whom they are often surprised. A chapter on this subject remains to be written. That there is a homœopathic dose of mind in a frog's cranium, I doubt not; but I am free to admit, so far as these *sill-hoppé tossers* of the Swedes are concerned, that I have never found much evidence of the fact. They approach as near to being mere automata as any creatures I know.

The pickerel-frog may be said to differ from the preceding in the number and position of a few spots on the back: the herring-frog has the spots in two rows, while in the pickerel-frog they are in four. This is the one apparent difference, though there may be others not as marked. This slight variation in color and markings is constant and uniform, and it must have been brought about by some potent cause, supposing that these and our other frogs are derived from some ancestral type which is at once like, yet unlike, the five species that now frequent our meadows; and no other supposition is tenable.

I have tried in vain to detect some difference in habit, or variation in date of appearance, or preference for different localities, of these two kinds of frogs; but all in vain. Where the one is, there we find the other also, and the two species even keep up their croakings in concert. Possibly, there may be a little difference in their voices; but of this I am not sure. Of the fact, that they belong to two species, there can be no doubt, and, as this difference can not be one of color alone, it is idle to suppose that we are acquainted with the full history of their lives. This we shall never be until we discover some action that is habitually performed by one and not by the other, or until we discover some places that are frequented by one and as carefully shunned by the other.

What claims, it may be asked, have these frogs upon us? This is easily answered. They are not only great checks upon an undue increase of insect life, but they are also scavengers. They do not, it is true, wander about the uplands in search of decaying animal-matter; but in the waters they frequent they consume much that would otherwise render them impure. The minute larvæ of aquatic insects are destroyed by them in vast quantities, and such decaying animal-matter as collects in every spring and running brook is likewise consumed. If care be taken to exclude every frog and salamander from a spring, it will be found that very soon the water will not be so pure, however strong the current, as is that of a frog-frequented spring. I have proved this by several careful experiments, and it can only be explained by the fact that these frogs feed upon such organic matter as would, in time, if allowed to remain, affect the quality of the water. In these frogs, then, we have beautiful, harmless, useful, and cheerful, if not, strictly speaking, musical animals. Is not their title to our good wishes well established?

There are other frogs, though, that will attract attention, if we wander by the brookside, with an eye to whatever is to be seen. A beautiful species, usually called the spring-frog, is likewise very abundant in the meadows, where, all the day long, he sits quietly on the bank of a ditch, unless alarmed, when he gives a great, flying leap, and dives into the depths with a loud splash. Not content with this, he burrows into the mud or hides in the grass, and it then takes a sharp pair of eyes indeed to discover him. When I startle a herring or pickerel frog, I can not tell which it is until I get a glance at the spots on the back. Both move alike; and they jump into the water with a neat dive that scarcely ruffles the surface. It is otherwise, however, with the spring-frog. When I see him flying through the air, with all legs well spread, and hear the splash, I say at once, "clamitans," and nine times in ten I am right.

This large green frog is not so sensitive to cold as the preceding, and, though "mum" after a frost, it will nevertheless be fully as active as in summer, and will skip over the dead grass with marvelous speed if it suspects any danger. While, perhaps, not the earliest to sing during the few spring days which we sometimes have late in February, yet it follows very closely in the wake of the others, and repeats much the same sounds, but in a deeper voice—a sort of bass accompaniment to the treble of the herring-frog. Here, perhaps, it would be well to mention that Kalm's impression, derived from the Swedes, that the singing of the herring-frog announced the arrival of the herring, is not quite correct. They anticipate the coming of the fish, by from two to three weeks, in five years out of every six. This is true of late years, and it is doubtful if the herring ever came any earlier than now.

I have usually found the eggs of this frog, in May, attached to long grass. They are larger, and are deposited in bulky, irregular masses of a glossy, gelatinous substance, which holds them safe, even in strong currents of water, until the eggs are hatched. So conspicuous are these masses of ova, that I have often wondered why they were not devoured by the fishes and turtles. These animals, however, do not appear to molest them; at least, I have never seen either turtles or fish in the act. This is negative evidence, it is true, and must go for what it is worth.

Unlike the frogs already mentioned, the spring-frog does not hibernate with the regularity supposed to be characteristic of these animals generally. Every winter I have found that several took up their residence, for the season, in the deep water of a large spring near the house. This gave me abundant opportunities for observing them, and I found that while they remained at the bottom of the spring more than they did during the summer, yet they occasionally came to the surface, and stuck the tips of their noses just out of the water. I believe they took no food from November to March. Indeed, I could not see any living prey for them to take; and the fact that, in several specimens which I dissected, the digestive tract was quite empty, confirmed me in the supposition.

Occasionally, in my rambles, I have chanced upon deeper ponds and more retired spots, where, thinking naturally of fish, rather than frogs, I have been startled, as I passed carelessly along, by a loud splash, or a deep note as hoarse as that of a bull in some neighboring pasture, but not otherwise similar. I had startled a bull-frog.

From the high bank, into the deep water, away he had gone, and my chance of seeing him again was indeed small. This deep-voiced, noisy, splashing frog is the largest of the five species common to New Jersey, and, when full grown, it is a rather formidable-looking creature, though, like all the frogs, it is of course quite harmless.

The bull-frogs did not fail to attract the attention of Kalm when traveling through New Jersey, and he relates some marvelous stories concerning them. His account is as follows: "Bull-frogs are a large species of frogs, which I had an opportunity of hearing and seeing to-day (May 5th, 1749). As I was riding out I heard a roaring before me, and I thought it was a bull in the bushes, on the other side of the dyke, though the sound was rather more hoarse than that of a bull. I was, however, afraid that a bad goring bull might be near me, though I did not see him, and I continued to think so till some hours after, when I talked with some Swedes about the bull-frogs, and, by their account, I immediately found that I had heard their voice; for the Swedes told me that there were numbers of them in the dyke. I afterward hunted for them. Of all the frogs in this country this is doubtless the greatest. I am told that toward autumn, as soon as the air begins to grow a little cool, they hide themselves under the mud which lies at the bottom of ponds and stagnant waters, and lie there torpid during winter. As soon as the weather grows mild toward summer they begin to get out of their holes, and croak. If the spring, that is, if the mild weather, begins early, they appear about the end of March, old style; but if it happens late, they tarry under water till late in April. Their places of abode are ponds and bogs with stagnant water; they are never in any flowing water. When many of them croak together they make an enormous noise. Their croak exactly resembles the roaring of an ox or bull which is somewhat hoarse. They croak so loud that two people talking by the side of a pond can not understand each other. They croak all together; then stop a little, and begin again. It seems as if they had a captain among them: for when he begins to croak, all the others follow; and when he stops, the others are all silent. When this captain gives the signal for stopping, you hear a note like '*Pŏ—óp!*' coming from him. In day-time they seldom make any great noise, unless the sky is covered. But the night is their croaking-time; and when all is calm you may hear them, though you are near a mile and a half off. When they croak they commonly are near the surface of the water, under the bushes, and have their heads out of water. Therefore, by going slowly one may get close up to them before they go away. As soon as they are quite under water they think themselves safe, though the water be very shallow.

"Sometimes they sit at a good distance from the pond; but as soon as they suspect any danger, they hasten with great leaps into the water. They are very expert at hopping. A full-grown bull-frog takes near three yards at one hop. I have often been told the following story by the old Swedes, which happened here at the time when the Indians lived with the Swedes. It is well known that the Indians are excellent runners; I have seen them, at Governor Johnson's, equal the best horse in its swiftest course, and almost pass it. Therefore, in order to try how well the bull-frogs could leap, some of the Swedes laid a wager with a young Indian that he could not overtake the frog, provided it had two leaps beforehand. They carried a bull-frog, which they had caught in a pond, upon a field, and burnt his hips; the fire and the Indian, who endeavored to be closely up with the frog, had such an effect upon the animal that it made its long hops across the field as fast as it could. The Indian began to pursue the frog with all his might at the proper time: the noise he made in running frightened the poor frog; probably it was afraid of being tortured with fire again, and therefore it redoubled its leaps, and by that means it reached the pond before the Indian overtook it.

"In some years they are more numerous than in others; nobody could tell whether the snakes had ever ventured to eat them, though they eat all the lesser kinds of frogs. The women are no friends to these frogs, because they kill and eat young ducklings and goslings; sometimes they carry off chickens that come too near the ponds. I have not observed that they bite when they are held in the hands, though they have little teeth; when they are beaten they cry out almost like children. I was told that some eat the thighs of the hind legs, and that they are very palatable."

If the above is correct in all its parts, then we have few, if any, such bull-frogs as Kalm saw in 1749. The environment has grown yearly less desirable, and degeneration has set in. In a few score generations more the mammoth bull-frog itself will have gone the way of the mastodon and great auk, and there will be left but a few pygmy descendants to testify to its great size.

Let us, however, take up Kalm's description by sections, and see how it applies to the indefinitely great-great-grandchildren of the frogs of his time. And, first of all, as to its voice: can any one say now that the familiar notes, often and aptly likened to "jug-o'-rum, jug-o'-rum," has a bovine sound? Of late I have lingered long in the meadows, listening to the bull-frogs in the ditch hard by, and then to the mooing of the cows as they come from the pasture. Perhaps there is a similarity, but I could never detect it. So common, however, is it to hear the comparison made, that I suppose the resemblance must have been true of them formerly, if not now. Gabriel Thomas, in his quaint little history of Pennsylvania, published in 1698, speaking of the various sorts of frogs, says there is "the *Bull-Frog*, which makes a roaring noise, hardly to be distinguished from that well known of the Beast from whom it takes its Name." I can only go so far as to admit it is a deep bass note, but always well defined, and not a roar, even when a dozen are croaking together. Kalm's description of their croaking in concert is excellent, but it would be better to say that each concert has its leader, rather than each company its captain. The latter, if true, would be evidence of considerable intelligence; but it is only apparently true of them. I have very carefully watched the bull-frogs in a pond near my house, and have found that the croaking of the "captain" is not always that of the same individual. At times the initial croak would come from one side of the pond, then the other, and so continue to vary. This shows at once that not any one individual started and stopped the croaking of its companions.

As to their leaping, Kalm is extravagant in his estimates. He says "near three yards at one leap," but does not say how near. The biggest old "bloody-noun" I could ever find could not, or would not, hop three yards at one hop for me, although I spurred him on in many ways, even to scaring him with a snake. The longest hop fell short of seven feet by some inches. Perhaps the frogs in Kalm's time were larger than those that grow about here to-day, or it may be that they made spring-boards of lily-leaves, and so had a decided advantage in jumping. As to the running-match with the Indian, it is evident that the latter could not have been in running condition that day, or he would have done better; possibly he was a little rheumatic. The fact is that our modern frogs get out of wind after three or four consecutive hops, and are readily overtaken; and it is probably for this reason that they are careful never to wander too far from water, as they know that, in proportion to the distance they go inland, they increase the danger of exposure to snakes; but, when on the bank of the pond or ditch, they can easily avoid an enemy by one leap into the water, and often into the deeper mud beneath it. Stupid as frogs appear to be, they merit the credit of this degree of intelligence. Again, it is strange that there should have been any doubt as to the fact that snakes ate the bull-frogs, however large they might grow; for it is no uncommon occurrence for a slender whip-lash of a garter-snake to dispose of a meadow-mouse. By some mechanical ingenuity and physiological black art, their little jaws drop apart wide enough to take in the mouse, and down it goes into a darker retreat than any that it had previously explored. It is scarcely necessary to entertain the suggestion that perhaps snakes formerly did not eat bull-frogs, as that is nonsense; but strange indeed is it that Kalm should have been in any doubt about the matter.

It is, on the other hand, all too true "that they are very palatable," and to this unfortunate circumstance must be ascribed the fact that these great goggle-eyed frogs, that lend such a charm to quiet ponds and hidden swampy hollows, are now comparatively scarce.

Out of the meadows and into the woods, away from the muddy ponds and stagnant puddles, to the leafy haunts of squirrels and chipmunks; and here, if it be even a little damp, we may chance upon another frog, which in color, habits, and disposition is unlike all the others. I mean the little brown wood-frog. It is literally quick as a flash, and for some reason has a great dread of mankind; at least, it takes wonderful leaps, and plenty of them, whenever any one happens to come too near. I know of no harder task than to chase a wood-frog over uneven ground.

Except in April, when they congregate at some neighboring pond and lay their eggs, these frogs frequent the woods the year through, feeding on flies and such small fry until frost comes, when they burrow some two feet deep in damp earth, and there they remain until the weather has become fairly spring-like.

By people who ought to know better these wood-frogs are confounded with the tree-toads. Why two creatures so unlike should be mistaken for one another passeth comprehension; yet, in spite of all the zoölogical literature, and thousands of school-teachers, such is the fact. Worse than this: I know of a lad, with a correct knowledge of our batrachians, who dared to correct his teacher on this matter while on a Saturday fishing-frolic, and who was in turn "corrected" by the teacher on the following Monday.

Here, then, we have five well-marked species of frogs, all found in great numbers in this one limited locality, and available to the student every day in the year. That they have taught me so little is my fault, not theirs.

A toad-like creature, yet differing from toads and frogs, is known among naturalists as the "hermit spade-foot." It is seldom seen; more seldom is it to find any person who has knowingly seen one, and, if it should happen to be accidentally encountered, the average citizen would, if he looked at it at all, probably say "hop-toad," and never suspect that it was a very different animal. But, then, why should he, as the average citizen does not usually want knowledge that can not be converted into dollars and cents?

The spade-foot is wholly terrestrial in its habits. Like the frogs and hop-toads, it goes to the water to spawn, but at no other time. The eggs are placed around a single spike of grass, and are said to hatch in six days. The growth of the tadpoles "is very rapid, not more than two or three weeks elapsing before the young toads leave the water."

My first acquaintance with the spade-foot was in May, 1874. Passing, early one morning, by the side of a shallow pond, thickly overgrown with rank vegetation, my attention was called to a peculiar and very loud noise, coming from the water, and which was quite new to me. As has been remarked by a prominent naturalist, "the peculiar, harsh croaking of this singular toad must be heard to be appreciated, and can then never be confounded with that of any other species. The only sound we can liken it to is that of a heavily-loaded, creaking wagon rolling over hard and uneven ground." As I can not improve upon it, I will let this go as a description of the noise spade-foots make; but it does not, by any means, do justice to their squealing, grunt-like croaks.

On hearing, for the first time, this fearful racket, I straightway turned my steps pondward, and found the place literally alive with the toads. At first glance I took them to be the common species, but was puzzled by the sound. Then, on closer inspection, I found them to be the rare spade-foots. They continued in the pond for five days, but made but little noise during the last two. On the sixth day there was not one to be found anywhere about. I searched for several days, but found no trace of them, nor have I seen one in the eight years that have passed since that time.

This toad may be described as a terrestrial batrachian which burrows "in the damp earth, a few inches below the surface, which it excavates with great ease by means of its spade-like processes or sharp-edged spurs growing from their heels. In these holes it lies in wait for such insects as may approach, and I suspect can spring forth to seize whatever may be passing incautiously near its hiding-place. I remarked, at least in those which I had alive, that it leaped with great apparent ease to a considerable distance." So writes De Kay, in his "Natural History of New York."

Another batrachian with which all are more or less familiar, unless their whole lives have been spent in a large city, is the tree-toad. Unlike the common toad, which is terrestrial, or the frogs, that are aquatic, this animal leads an arboreal life. In anatomical structure, therefore, it differs from both the others, so far as this is necessary to its peculiar mode of life; the most prominent variation being found in the fingers and toes, which are more or less dilated into disks at their tips.

This little tree-toad soon attracted the attention of the early colonists of New Jersey, and I find mention made of it as early as 1698. Gabriel Thomas, whom I have already quoted, refers to a "sort of *Frog*, that crawls up to the tops of Trees, there seeming to imitate the *Notes* of several *Birds*." The idea of the resemblance of its note to that of "several birds," or of any one kind of bird, is rather amusing. Like all of our batrachians, the tree-toads make their way to the water as the proper place for depositing their eggs. These eggs are "attached singly and in small groups along the grasses resting on the water's surface." Eggs deposited on May 10th are recorded by Miss Hinckley, in the "Proceedings of the Boston Society of Natural History," to have hatched two days later, and passed through the tadpole state by July 4th, when the tadpoles were found "at the water's edge, with the tail reduced to a mere stump."

My own knowledge of these little creatures covers only their arboreal life. I have never seen them except in their high and dry quarters; not always dry, either, for they love damp hollows in the angles of the branches where a little rain lodges.

The old apple-trees in the lane are sure to be tenanted by several tree-toads every year, and the little that I have learned of them has been by watching those that frequented this one locality. This, by the way, is not recommended as a safe way of studying the habits of animals, as there would be nothing improbable, from what we know of other animals, in tree-toads acting quite differently in different trees. Suppose them, for instance, to be hiding in a cedar or in a weeping-willow, and it is evident that trees so widely different would make it necessary that their movements when in pursuit of insects should be quite different, for they do not sit quietly in one spot, trusting to sufficient prey coming within their reach. I have not been able to learn how far these animals vary in the choice of their haunts, as I know them almost only as frequenting the apple-trees.

As is well known, the tree-toad is nocturnal and crepuscular in its habits. By day it sits very still in some quiet nook. By sitting still it must not be supposed that it makes no noise. Far from it. Let a patch of cloud as big as a barn-door cast a shadow over it, and the fretful fellow at once begins to croak. This croak is so very generally regarded as a sign of rain, that it almost invariably calls forth the remark, "It is going to rain," from some one who has happened to hear it. Even the Indians looked upon it in this light, and so did the Swedes in South Jersey. I am sorry, however, to have to say that the toads in the apple-trees have undermined my faith in the "sign," as they have not shown themselves superior in prophetic ability to the man who gravely informs us what the weather will be when the indications are unmistakable. The croaks and the coming rain, so far as my apple-tree toads are concerned, are mere coincidences—nothing more—as the following observations will show: In 1880 the tree-toads croaked every day from May 9th to July 12th, both inclusive, and there were but six wet days during the sixty-five. The next summer gave the same results; and during the early part of the summer of 1882, during which there was a considerable drought, it was the same thing. They croaked more or less every day, hot or cool, sunshine or clouds, and far more at noon-time than either in the early morning or at evening. The supposition that they are particularly noisy at night is wholly inapplicable to my apple-tree toads. Had I never heard anything about these animals, I should have reported them as croaking not because it was likely to rain, but because it was so dry that they were suffering for want of moisture. After an unusually hot day, during the early summer, I have noticed that they croak a great deal after sunset, when the air becomes damper, seemingly out of pure satisfaction at the desirable change; while during our annual summer drought they croak much at mid-day, and this, I have thought, was a cry of impatience uttered in anticipation of the refreshing bath of dew that only comes with night-fall.

When we do have a fairly wet season, these tree-toads are less full of croak than during a dry one; and never have I been able to detect the slightest connection between the cries of the apple-tree toads in the lane and either a passing shower or a coming storm.

It may be asked of the tree-toad, as of many another of our fauna, are they as abundant as formerly? In answer to this, I quote Captain Jonathan Carver, who, in the concluding chapter of his "Travels in North America" (1766–'69), says: "These creatures . . . infest the woods in such numbers that their responsive notes at these times make the air resound." The rest of the notice is a mixture of truth and absurdity, and is omitted; but the portion quoted would indicate that either tree-toads were formerly more abundant than at present, or that the author has confounded the animal with some one of the true frogs.

The tree-toads, while always at home during the day, are as active as a hop-toad during the night, and wander about the home-tree in search of food. Unless disturbed, however, they do not, I think, go far away, certainly not so far that they can not find their way back. I have long thought that they made one tree their home, and I know, from observations extending over several summers, that the same tree-toad will spend the day, the summer through, in the one spot on the tree. From April to October, without a miss, except when making the journey to the nearest water to lay eggs, I have known a tree-toad, day after day, to stick to one and the same spot, wherever it might travel through the night. Of course, such regularity of habit must be coincident with an abundant food-supply. Let this once become uncertain, and, like sensible toads, they would quickly change their quarters; but any change of locality is probably from necessity, not choice.

I have never been able to find out whether this batrachian had any enemies. The snakes that climb trees, as the black-snakes, do doubtless sometimes make a dinner upon them; but our climbing snakes are few, and hence the inference, that they have less to fear than either the frogs or toads, though they are by no means so numerous.

There is yet another species of tree-toad, called Pickering's hyla, which is found about here, though it is not so common. Its place is taken by the little green and brown batrachian called the cricket-frog, or "peeper." This species is not a true tree-toad, or hyla, as there is a little twist in its muscles and a wrinkle in the bones which the other does not possess; so, instead of rejoicing in the pretty scientific name *Hyla*, we must call it *Hylodes*, if we speak scientifically; but to me the little fellow is always a "peeper."

One of the cheeriest of the many early spring notes is the clear, bell-like voice of this little animal. We hear it wherever we go, though we do not so often have the opportunity of seeing him in the act of "peep"-ing. One Saturday evening, late in April, 1882, as I was walking along the bank of a narrow ditch in the neighboring meadow, I was startled by the shrill "kweép" of a "peeper." I say startled, for the sound seemed to come from directly under my feet, as though I had trodden upon the little fellow and crushed this one agonized cry from him. Instantly I stopped, and waited patiently for several moments. All was silent, until I imitated the cry as best I could, when immediately the little frog answered me. I knew then that he was not even hurt, and straightway I began to search for him, as I was very anxious to see one uttering the shrill note peculiar to its species. I first stooped; but failing in this to get a glimpse of him, I then lay flat upon the damp meadow. At every change of position the little fellow ceased his shrill cry; but a moment's quiet on my part restored his confidence, and the piercing "kweép" again sounded so shrilly that I was confident the animal must be within a foot of my face. Still I failed to find him. Not discouraged, but fearful of rheumatism, I was about to retire, when I was joined by my son, who took a position near by and scanned the grass along the ditch-bank, as only his younger eyes could; and he soon discovered the little hylodes upon the opposite bank of the ditch, much farther away than I had supposed. We had a full view of him, as he was clinging to two blades of grass in a perpendicular position, head up and hips down. The note or "kweép" was preceded by the formation of an immense air-sack in the throat. This was as large, I thought, as the animal itself. As suddenly as it came, the sack disappeared; and simultaneously with the collapse came the shrill note I have described. The whole act was so rapid that I could scarcely follow it, though I saw enough at the time to satisfy me that the sound was produced by the escape of the air that filled the enormous sack at its throat.

During the month of April, 1881, I had an excellent opportunity for observing these creatures; and, finding that but little had been recorded concerning them, I availed myself of the chance with all the more earnestness, and watched them closely for several weeks.

While a network of ditches in a low meadow were being repaired, extended, and cleaned, I followed the workmen closely, for the purpose of gathering any novelties that might be thrown out with the mud and dead leaves that had accumulated in them. Much of interest was found; but the one striking feature of the locality at this time was the wonderful abundance of little "peepers," or, in dignified language, hylodes. They were in full song, and when not disturbed, made more noise than all the frogs in the neighborhood. They were quite timid, however, and, on being approached, were straightway "mum." Their vocal efforts seemed to increase until the first week in May, when their eggs were deposited in little masses which were attached to the blades of rank grass floating on the surface of the water. I did not succeed in following the various stages of developmental growth from the egg to the matured animal, but I was enabled to determine that it was more protracted than in the common tree-toad. The difference is, I am led to think, about six or seven weeks. The tardiness of growth is occasioned by the slow development of the limbs, which do not, I think, begin to grow until late in the summer.

From the date of their earliest appearance in spring in considerable numbers until about the last week in May the meadows are literally alive with them. Wherever the ground is at all wet, they are to be seen as thick as grasshoppers in August. Extremely active and quite shy, they are difficult to catch, in case the pursuit is confined to a single individual, but, by sweeping an ordinary dip-net along the grass at the edge of any little pool, several are certain to be taken. They feed ravenously at this time, and, even when confined in very cramped quarters, they will devour any flies that may come within reach. On the other hand, they appear at this time to constitute the main food-supply of certain fishes, all the snakes, some turtles, and a few birds. I found that all our snakes during April and May were more abundant in the meadows than elsewhere, and there can be no doubt that they were drawn thither for the purpose of feeding on these little batrachians. Even that lover of high, dry, and dusty fields, the hog-nosed snake, was found at intervals along the banks of the ditches, apparently on the lookout for "peepers," and the dissection subsequently of one of these snakes proved that it had fed upon them.

About the middle of May there was a very noticeable diminution in their numbers, and by the close of the first week in June not a specimen was to be found. High and low, up hill and down dale, it mattered not where I looked, not a trace of an adult hylodes could I discover. Can it be that their vigor culminates with the maturity of the ova and spermatozoa, and that, having spawned, they have no vital force remaining, and so, in the course of a few weeks after ovipositing, they die? If this be so, then weeks must elapse without a representative of this batrachian being in existence, and the race is preserved in the tadpoles that swarm in the stagnant ponds and sluggish ditches. This continues until August, when these tadpoles become fully developed "peepers."

In September their numbers greatly increase, and now they spread over a wider range than they seemed to frequent in April and May. Indeed, in the autumns of 1881 and 1882 I found very few in the meadows, but thousands were in damp, upland nooks, as, for instance, about the springs and particularly along a brook where the water flowed rapidly over a pebbly bed.

Early in October, 1881, I found a number of these "peepers" in a little ravine, through which a brook ripples riverward. I noticed at the time that these little creatures had a decided aversion to the water. Necessary as it was for them to keep their skins moist, they had no desire to become thoroughly wet, and when by chance they made an unlucky jump and settled in the water, they straightway crawled out and took up a high and dry position on some projecting stone. If in the sunlight, so much the better. A bath seemed to chill them, and whenever I drove one into the water, I found that for several minutes after it emerged I could pick it up without difficulty; but in time it would regain its ordinary activity, and then quick indeed must be the movements of any one who would catch such an one with the hand alone.

It was at this time, too, that I gave close attention to the subject of their color and its changeableness.

While there are certain peculiarities of color that are persistent and characteristic of the species, these, at times, become of little prominence, so very great is the difference in the entire coloration of the animal. Furthermore, they change their hues with great rapidity, and during the course of a few moments will pass from an ashy paleness or clay color to an intense black, with the light dorsal stripe scarcely visible, or else either of a glowing red or a brilliant metallic green. So very beautiful are these colors, and so different in appearance will any half-dozen of these animals prove to be, that it is difficult to realize that they all belong to one and the same species.

Of a series of six which I have long kept in confinement (October 20th to January 29th) in a bottle, one specimen was taken from a ledge of pale yellow clay. The "peeper" was of the same color, the post-orbital dark spot and light dorsal line being scarcely discernible. The uniform yellow tint, however, was relieved by minute round points of brilliant bronze. This individual, unlike its companions, did not alter in color for several weeks. The others were very changeable, and particularly so when exposed to direct sunlight. While I noted several instances to the contrary, my impression is that usually the colors pale in direct sunlight, and deepen when the animals are in deep shade. This certainly is true of those I have in confinement, and agrees with my experience in searching for them during the past autumn. One fact with reference to the subject of their color is not in accordance, perhaps, with the above, but should not go unrecorded. The six individuals which I have in a bottle will, at times, present very different tints, although all are subjected to like surroundings. Of the six, two or three would be very dark, the others pale yellow. With some the dark triangular spot between the eyes would be very distinct, in the case of the others it could not be detected, even in outline. It must be remembered, however, that these individuals were kept in most unnatural conditions, and though, at the time of this writing, they had been without food for one hundred days, yet they were as active as squirrels.

Sensitive as these "peepers" are to changes of temperature, it is by no means the first frost that drives them into their winter quarters. In the autumn of the past year (1881) I found them as late as Nov. 12th, and even later (Dec. 27th) my son found one in the meadows which was as lively as a cricket. The frogs generally were singing this day. For more than two weeks prior to Nov. 12th there had been several white frosts, and the true frogs (*Ranæ*) had all disappeared except the few that lingered in the warm waters of the larger springs. Not so, however, with the "peepers;" the cozy, sheltered nooks in the ravine I have mentioned afforded them comfortable quarters still, and after a severe rain-storm, which lasted for three days, I found numerous specimens near the brook, always in moist places, but not where it would be called wet. In many instances they were found adhering to the under sides of projecting stones, roots of trees, and even to large oak-leaves. I find it stated by De Kay, in his "Natural History of New York," that they can not retain their hold upon the under sides of projecting objects; that the disks on their toes are not sufficiently large. This is an error; indeed, the specimens I have in a bottle can retain their hold when the bottle is turned over.

My impression is, that they do not require or partake of any food during their brief experience as matured "peepers" in autumn, i. e., from completion of the growth of their limbs in September to the commencement of their hibernation. My reason for this is based upon the fact that the specimens in a bottle, to which I have referred, were placed in confinement on the 20th of October, 1881, and the date of writing, January 29, 1882, a period of one hundred days has just elapsed. During this time these "peepers" have had no food, have been quite as active as their limited quarters would permit, and yet have not lost weight to any important extent. One which I weighed on the day following its capture weighed forty-four grains, and seventy-five days later had lost but one grain.

In the spring it is very different; then they are voracious feeders, and capture millions of insects. At this time their stomachs are always full, and, while the size of the animal is not noticeably larger than it was in autumn, yet the weight is nearly twice as great. Their physiological activity apparently culminates with the maturing of the ova and the labor of depositing and fertilizing it, as I have already suggested. This effected, these little "peepers" are worn out, and, as I am forced to believe, the greater number, at least, soon die.

Going back to the high and dry land, there may be found a common batrachian—the familiar hop-toad—about which many errors are rife, and which is therefore entitled to an extended notice.

It is probable that the absence of all attractiveness has had much to do with the indifference with which toads are regarded, and, in justice, it must be admitted that the toad is superlatively ugly. This, however, should interest rather than repel the student, since this black and brown ugliness is an excellent instance of protective coloration. So inconspicuous is this toad, when in its ordinary haunts, that it has but to sit still and let its food come unsuspectingly within reach. Then it is seized, but so quickly that it takes a sharp eye to follow the movement. Whoever hates flies should love the toad. It would be hard to determine just how many it will devour in the course of twenty-four hours, but a fair estimate can be made. For instance, two summers ago, a lazy, aged toad took up its quarters by the kitchen-door. A convenient cranny in the brick pavement was its home; but it sallied out often, even in broad daylight, to feast upon the innumerable flies. Once, watch in hand, I timed it, with the following result: In three minutes it captured twenty-nine flies, supposing that it never missed its aim. The toad looked like a child's rocking-horse while thus engaged, and no wonder, for once in every six seconds it leaned forward, shot out its tongue, and then came back with a flop to its original position. Then out again and back, and so it kept up for the three minutes. Then a pause of three or four, during which a new lot of flies accumulated, and the three-minute job was repeated. This toad has been a fixture in the kitchen-pavement for nine years, and, I am happy to add, still lives. Think kindly of toads, then, all ye who have a horror of flies.

Although a nocturnal animal, the toad is by no means disposed to remain idle through the day. It is, however, only after sundown that protracted foraging expeditions are undertaken, and it is only at that time that it sings! Why not call it singing? Frogs "sing," in common parlance, although some ill-natured folk call it grunting, and the toads certainly have an equal right to have their vocal efforts similarly named. It is a deep, penetrating, metallic rattle that may be heard a long way off, and, when one after another repeats the note, it becomes a feature of the serenade with which our country folk are nightly favored during the summer months. The frogs get the credit of the performance with many, but this "mixing" of different things is not unusual in matters zoölogical.

One word more. Toads *do* go to the water to lay their eggs, and these eggs do *not* hatch into hoppers, but into little tadpoles, which have to wait with patience for their legs to grow. Then these ridiculous miniatures of their sedate parents come hopping from the ditches in regiments and brigades, and were it not that very many of the birds, mammals, and reptiles in the neighborhood fatten on them, we should soon have a plague of toads. As it is, we have not half enough.

Every one of the preceding batrachians, ten in number, have been placed in an "order" called Anura—that is, they are tailless. Perhaps this may seem contradictory, for every one had a tail when it was hatched, and with some this appendage was larger than the whole body. In time, however, these tails dwindle away, and wonderfully well-developed legs appear, and no one, seeing a frog or toad for the first time, would ever suspect that once upon a time he sported a tail.

Before completing our cursory glance at the batrachians we must again return to the haunts of the frogs and turtles, for there are in these damp nooks and crannies a whole host of creeping, slimy, and often gayly-painted creatures, which the ignorant will persist in calling water-lizards; and generally a libel, to the effect that they are poisonous, is added. These animals are collectively known as salamanders, and may briefly be defined as lizard-shaped, but with the body naked or without scales. Unlike the frogs, they have tails—not little stumps, but long, slender, whip-lash appendages—that wiggle as the creature runs, and are of no earthly use whatever, and probably never were. Indeed, snakes and turtles nip them off very frequently, and the salamander seems to thrive all the better for it. Indeed, so much are they benefited by the operation, that a race of tailless salamanders ought long since to have been Darwinized into existence. However, it has not been done, and, though the tails are of no known use, yet the salamanders will persist in cultivating the useless appendage.

There is a strong family likeness running through the list of these animals, which may number ten species in this neighborhood, although I am not certain of the identity of more than four. Externally they vary in color and in the length of the tail, and, if we could only classify them accordingly, the difficulty would end; but my friend, Professor Cope, has assured us that some are opisthocœlian, and others amphicœlian. Think of that, and fail to pity the poor salamanders, if you can. Then some have ossified tarsi and carpi, while in others these are cartilaginous. It is bewildering to contemplate, but in spite of it all the salamanders keep up their courage, and wriggle and twist, swim and dive, catch flies and sing songs, just as though these terrible things had never been said about them.

In my rambles about home I have found four well-marked species of these salamanders in abundance. One is quite terrestrial, being content with moderately damp ground. Two others may be considered as "on the fence," it being uncertain whether wet land or running water suits them better, while the fourth is strictly aquatic.

The first of these, and that which is strictly an aquatic salamander, is the pretty spotted triton. This little creature is as much at home in the ponds and deeper ditches as any fish, and is far handsomer. It is green above and yellow beneath, and its sides are decorated with vermilion spots, each one of which is margined by a black ring. Not even the sunfish can boast a greater wealth of color.

In its habits it is both frog- and fish-like. Early in the spring it comes from its winter-quarters, which I could never discover, and swimming in and out among the bunches of floating dead grass, or haunting such hardier growths as have not been winter-killed, it occasionally lifts the tip of its nose just above the surface of the water, and gives a clear, metallic "peep." This is not so loud as that of an hylodes, or "peeper," though resembling it in other respects, nor is it so frequently repeated. Indeed, I have always considered it quite an event to detect a triton in the act of "peeping," and I should not have suspected their vocal powers if I had not heard one "give voice" in the aquarium, where it had been confined for many months.

Like all our frogs, these salamanders lay "bunches" of eggs, which are attached to floating blades of grass. These are soon hatched, and then the young shift for themselves. Like all such young fry, however, they run but little chance of ever reaching maturity, for the mud-minnows, young turtles, and, in fact, every creature larger than themselves, inhabiting the same pond, gobble them up most unceremoniously.

I am compelled to write thus briefly about them, for, while I have seen both the eggs and very young tritons, I have never watched the process by which the former develops into the latter. This is yearly postponed, on account of a press of other novelties, and now I can only hope to induce some one else to undertake the task.

De Kay tells us that this salamander is capable of withstanding a low temperature, and thereby gives ground for the inference that other salamanders can not. This, I think, is not true, as they all can bear a considerable degree of cold, and even when frozen they have been known to recover promptly if thawed out very gradually. While hibernation is, I doubt not, a habit common to them all, it is certain that during what are called "open winters" they retain their wonted activity from November to March, and this, too, without food of any kind. Whether they live on their fat, or whether there is some arrest of the natural decay of tissue, I can not say; but I have often, during winter, found our semi-aquatic salamanders in warm spots, possessed of their usual activity, and yet in localities which I supposed to be destitute at the time of any food-supply. My efforts to determine, by dissection, the contents of their stomachs during winter were not satisfactory, and I had to content myself with the fact that if there were any food in their stomachs it was in very minute quantities.

A second species of these creatures, remarkable for its activity and strength, is the dusky salamander. To find it we must leave the muddy ditches and grass-grown ponds wherein the triton delights, and seek some babbling brook with plenty of big stones in its bed. Under these we are pretty sure to find this dusky species. When disturbed, away it goes with a jump and a wriggle, but not for any distance. The nearest hiding-place is sure to be its goal; and so, with a little care, they are easily followed, and the slimy creatures may be captured with comparative ease. Small though they be, their strength is considerable, and, before we realize the fact, a captured "dusky" will pry open your closed fingers and be off. Often I have lost an old fellow in just this way, being unable to realize in time what the creature was about.

Common as they are, I have never found their eggs, to my knowledge, but suppose that they are placed in localities like dripping moss or soaked leaves, that are constantly wet, and not in the running water. The young retain their external gills longer than do any of the other species found here. I had supposed that it was only for a year, but, according to Professor Verrill, two years must elapse before they acquire the breathing-apparatus of adult life.

More strictly terrestrial than the preceding is a third common salamander, which I find exceedingly abundant at times, and then a season passes when it is quite scarce. This is the red-backed salamander. The surest place to gather these is under the platform of the pump. No doubt now and then they plunge headlong down into the well; but, as they are not brought up mangled by the valve or the bucket, why should we care? I know they are about the pump, and suppose they are in the water we drink; but this is not a disturbing fact. I remember that the best springs always harbor frogs; so why not this non-jumping, tailed frog, for such it is. Under a board, if it be lying on moist earth, the "red-backs" love to linger. What they find to eat under there has often puzzled me, as I never could see any other living creature of which the salamanders could make a meal. There did not appear to be any trace of minute insects, and yet these salamanders thrive the while. To solve this question, I tried an experiment, but with only negative results. Finding a small colony of the salamanders under a plank near the pump, I waited until dark, and then, by the aid of a bull's-eye lantern, found that when all was quiet they came out from their diurnal quarters and foraged in a very systematic manner. They scampered about as restlessly as scuttle-bugs, and I suppose were hunting for insects. When I caused the light from the lantern to fall directly upon them, they at once started for the plank from under which they had come. I did not, of course, see one of them catch an insect, but it was evident that they are nocturnal, and, being so, they must habitually feed at night, although they do not scorn a bit of luncheon, even if it happens to be offered during the day.

With us the red-backed salamander lays its eggs first in June and then again in August. They are placed under wet moss and leaves, and likewise under the platform of the pump. In a very few days the eggs are hatched, and, unlike the young "duskies," the external gills commence to dwindle as soon as they are fairly in working order, and in three or four days not a vestige of them is seen.

The fourth common species, met with almost daily throughout the summer, is the beautiful pink, rosy, or red salamander. These are of all shades of red, and even when very old are purple. I have sometimes thought they had better be called the "inquisitive triton." Whenever the hydraulic ram, that formerly was our sole dependence for water, ceased to furnish us with the desired supply, I found a red salamander under the plunger. During the earlier years of my acquaintance with the pretty triton I never ceased to admire it; but of late my tastes have changed. Even in midwinter, and after sundown, by the light of a smoky lantern I have too often had to visit the troubled water-ram, and found my former friend, the red salamander, under the plunger. One winter, and that a hard one, satisfied me that these tritons are essentially inquisitive. There were individuals of other species roaming around at the time, and scores of more sensible ones, that took a long winter's nap, but never one of them disturbed the ram except these overgrown red fellows.

I think it can scarcely be doubted that all of our salamanders have voices. I have already mentioned the "peep" of the newt, or spotted triton. This large red salamander also has a clear, bell-like note, which, though frequently heard, is not usually recognized. It is a true hylodes note, and is often attributed to the little Savannah cricket, or "peeper," already described. They call, whistle, or give tongue, as you choose to express it, only in spring, and at the time when the females are depositing their ova. This, at least, is my impression.

There are yet others of this family that have been "collected" in the neighborhood; but here my knowledge ends. They *were* here, and now *are*—in alcohol. This seemed to satisfy those who were fortunate enough to find them; but of the value of such facts I have nothing to say.

The Intelligence of Batrachians.

In his recent volume on animal intelligence,* Mr. Romanes devotes less than two pages to the intelligence of batrachians. He remarks: "On the intelligence of frogs and toads very little has to be said." That our author should have included toads in the above seems strange, as instances of cunning and proofs of the general intelligence of these animals are numerous. In conversation with practical observers of animal life, I have never yet found one that did not accord a marked degree of intelligence to toads. In short, they may readily be tamed, will come when called, and have been seen to place matter attractive to flies, their principal food, near their hiding-places, so they could remain at home and at the same time be sure of a sufficiency of food. This evidence of foresight on the part of toads is no uncommon occurrence, and quite effectually establishes their claim to a creditable degree of intelligence.

Of the spade-foot or hermit-toad (*Scaphiopus solitarius*) and the tree-toad (*Hyla versicolor*) I have but little to record. The former is but rarely seen, and I have had no opportunity to experiment with it with a view to test-ing its mental capabilities. The habits of the animal, as described by Agassiz and Putnam, would lead one to conclude that intellectually they are to be classed with the common toad. The tree-toad, or *Hyla*, being crepuscular in habits, was found difficult to study, and nothing was determined that bore upon the question of its intellectual capacity. I can but state my impression, which is, that they are not so cunning as the common toad.

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* "Animal Intelligence." By George J. Romanes. (Internat. Sc. Series, No. xliv.) New York, D. Appleton & Co.

On the other hand, I am pained to confess that my many observations and experiments with the several species of true frogs found here, conducted without an intermission for four months, have yielded but little evidence that these creatures possess a particle of intelligence. It almost proved, indeed, to be labor lost—

> To perch upon a slippery log,
> And sit in judgment on a frog.

Mr. Romanes remarks that, if frogs are removed to a long distance from water, they will take the shortest route to the nearest pool or brook. Even this, I find, is only usually true. Quite ten per cent of such "removed" frogs started off, when released, in the direction of the most distant water, rather than that which was nearest. One of my many experiments was as follows: I placed a pail filled with water in a dry, dusty field, burying it to the brim. It was protected by a cap of coarse wire sieving. I then liberated a frog within twenty yards of it. It hopped in the opposite direction toward water nearly three hundred yards distant. I then placed a frog on the opposite side of the buried pail, so that the distant brook could only be approached by passing near or directly over it, if the frog took a direct course. This the frog did, and less than a score of leaps brought it to the water covered by the sieve. It seemed quite satisfied with the fact that a little water was in sight, although out of reach.

Here the frog remained until morning. The following day I removed the pail, and buried it within fifty yards of a running brook. I then took seven frogs of three species and placed them upon the sieve, which was about half an inch above the surface of the water. Here five of them remained during the whole day, exposed to the glare and heat of a cloudless midsummer day. The evaporation from the water beneath them barely kept them alive; and yet within so short a distance was a running brook, with all the attractive features of ideal frog-life.

I repeated this experiment, with slight modifications, several times, and always with essentially the same results.

Hoping to find that in the pursuit of prey, which is principally insects, frogs would display some intelligence, I tried several experiments to test their ingenuity; but it was of no avail. Unless the food could be easily reached by making the simple exertion of a single leap, the frogs would go hungry. Subsequently I placed a large fly upon a piece of thin mica, and surrounded it with a circle of fine needles, piercing the plate. The fly thus protected could only be seized by the frog suffering a severe pricking of the jaws. This, I found, a frog would suffer indefinitely, in its attempts to secure the fly. In one instance, the frog, which had been fasting for seventy-two hours, continued to snap at the needle-protected fly until it had entirely skinned its upper jaw. I concluded from this that the wits of a frog were too limited to be demonstrated.

Some weeks after having completed these experiments, I had the good fortune to capture two fully grown specimens of the bull-frog (*Rana Catesbyana*); and, noticing their enormously distended sides, I examined the stomach-contents of the two. In one was a full-grown chipmunk (*Tamias striata*); in the other, a garter-snake (*Eutania sirtalis*) measuring eighteen inches in length, and also a field-mouse (*Arvicola riparia*). On close examination I found that the snake had partially swallowed the mouse; and, while thus helpless, the frog had evidently attacked the snake, and swallowed it.

It is evident, I think, that the frog recognized the helpless condition of the snake at the time, and took advantage of it. If so, it is evidence of a degree of intelligence on the part of the animal which the results of my experiments with these creatures generally had not led me to expect. Certainly a frog, however large, will not attack even a small snake if it is possessed of its usual activity.

A wood-frog that I have now had for several months in a Wardian case shows, however, that the character of its accustomed haunts has necessitated the exercise of ingenuity to secure its food, and therefore its intelligence has increased beyond that of its aquatic cousins.

I have frequently noticed, when I placed flies in the case, that the wood-frog singled out one, and approached it in a very stealthy manner, squatting closely to the moss, hiding behind ferns and dragging itself along, until it had reached a position suitable for making a successful leap. If the fly moved, the frog would alter its position accordingly, and follow up the chase with great patience and unquestionable skill. At times it would happen that some one of the smaller batrachians kept in the case snapped up the coveted prize, when the disgust of the wood-frog would be plainly shown by his manner; but such an occurrence never led to a quarrel.

The aquatic frogs do not pursue their prey with anything like the same persistency and skill, even when they undertake it at all, and I am led to believe that the intelligence of the wood-frog has been increased by its terrestrial environment, and that it should be ranked with the common toad, which has already been shown to possess much cunning. In other words, the wood-frog has been forced to search for its food to a greater degree than the aquatic species have been, and hunger is probably the most effective stimulus to the growth of intelligence.

The salamanders, in the same way, by their active movements, wandering disposition, quickness of hearing, and other minor characteristics, give evidence of greater intelligence than that possessed by frogs. This I can state of them, however, as but little more than an impression; for my efforts to prove them possessed of much cunning were not successful. The purple salamander, it is true, fights when captured, curving its back and snapping viciously. This no frog ever does. The common spotted triton (*Diemyctelus*) becomes quite tame when kept in an aquarium, and, as I found, is soon able to determine the difference between a fly held against the glass and one held over the water. I frequently held a fly against the glass and very near the triton; but it took no notice of it, after one or two efforts to seize it, but would follow my hand, and, when the fly was held over the surface of the water, the triton promptly leaped at and seized it. This is, indeed, but meager proof of intelligence, but seems to show, I think, that a salamander is more cunning than the generality of frogs, but not the equal of the common toad.

My observations lead me to conclude that the habits of an animal have much, if not all, to do with the intellectual capacity it possesses. Frogs, as a class, are not migratory. They frequent a given pond or stream, and, sustained by the insect-life that comes to them, but is not sought, they pass an eventless life, trusting, as it were, to luck. Such an existence requires no intellectual exertion, and none is made. The salamanders, on the contrary, are far more wandering and active. They appear to be ever in search of food, and, when lying in wait for it, choose such positions as experience has taught them are best adapted for the purpose: at least, my studies of such specimens as I have kept in confinement lead me to believe so. Intellectually, therefore, the salamanders are in advance of most frogs; but the batrachians as a class, although higher in the scale of life than fishes, are, I believe, inferior to them in intelligence.

CHAPTER XXXIV.

BRIEF NOTES ON FISHES.

In front of my house, with only a pleasant stretch of meadow intervening, flows the Delaware. To my right, as I stand in the doorway facing the river, I can see, here and there, between tall birches and bending elms, a little silvery gleam that marks the course of a sluggish, lily-choked stream which creeps slowly westward from the foot of the terrace to the river. It is too insignificant a stream to merit the attention of the geographer, though it is worthy of a more than passing notice from the naturalist. Its source is in a series of little springs that come bubbling from the foot of the terrace or "hill" near by. Gathering volume as it wends its way riverward, it soon makes for itself a well-defined channel and glides slowly through a stately growth of reeds that are haunted by the king-rail and the little sora, the swamp-sparrow and the marsh-wrens. Beyond, the silvery birches and drooping elms shade its course and offer a safe retreat to the many herons that find a refuge there by day; and, in the garlanded month of May, I know of no spot in which the fresh foliage that then decks these beautiful trees more delights the northward-bound warblers or so tempts them to tarry in its shade. Still moving onward, the little river enters a denser growth and widens into a deep, dark, weedy pond, which is still so wild, retired, and tempting, that the wary wild-duck does not hesitate to visit it, while the fish-hawk loves it well; the stately herons wade along its muddy shores, and the mink, musk-rat, and otter still make it their home.

Still standing in my doorway, and looking to the left, I can trace, by the dense growth of forest-trees, a nobler stream, which comes from the distant "pines," and, after a tortuous course of many miles, is also finally lost in the greater volume of the seaward-flowing Delaware. Here we have a total change in almost every feature of the landscape. The swelling tide reverses the current of the stream for several miles, checking the growth of lilies, dock, and pond-weed. Being without obstruction on one side, the creek overflows the level reach of marshy meadow that scarcely defines the channel. On the opposite bank is the steep, winding terrace that here turns to meet the Delaware.

In these three streams the conditions are so different that we might well expect to find many fishes of many kinds. We are not, however, confined to these three streams alone, as there are scores of connecting ditches, and many spring-fed ponds, wherein the golden sunfish and the silvery minnow love to linger.

In all these places, whether river, creek, pond, or ditch, there are many fishes, both great and small. Let us, then, go fishing—fishing, not for the purpose of catching them, but of studying them. Many difficulties will beset us in this pursuit; but we are not without means of overcoming them, an unlimited amount of patience being the prime necessity.

The principal drawback to the study of the habits of fishes is, of course, our inability, under ordinary circumstances, to watch them in any large body of water, or in streams that have a rapid current. The most that we can do is to see them swim past and note the simple fact of their presence. By the aid of aquaria we have been able to remedy this difficulty to some extent; but still, if the habits of even our commonest fishes are to be thoroughly known, we must patiently pass hours by the water-side, and exercise our ingenuity in every way to determine what is going on in the depths below. One simple way of doing this, practicable at least in quiet ponds, is to insert a silvered tube, with a flaring or trumpet mouth protected by a glass disk, into the bottom of a boat or raft, and then lying down, to cover yourself with a blanket in order to exclude the light, and so quietly float along, looking through the submerged tube into the depths below. By this means you can see objects at great depths, especially if the sun be shining.

I was led to try this plan, because I had read, in Henry's "Travels in Canada," that in practically the same manner the Indians of that country determined the whereabouts of the large trout in winter, and speared them through holes cut in the ice. This author says: "In order to spear trout under the ice, holes being first cut of two yards in circumference, cabins of about two feet in height are built over them of small branches of trees, and these are further covered with skins, so as wholly to exclude the light. The design and result of this contrivance is to render it practicable to discern objects in the water at a very considerable depth. . . . . So completely do the rays of light pervade the element, that in three-fathom water I have often seen the shadows of the fish on the bottom following them as they moved, and this when the ice itself was two feet in thickness."

In the way that I have mentioned, years ago, I familiarized myself with the every-day life of all our commoner fishes; saw what food they ate and how they procured it; learned what were their enemies and how they avoided them; found out what fishes were sociable and which were solitary; saw abundant evidence, in short, of their possessing a sense of pleasure, of fear, cunning, and memory; and with these faculties, even if exercised in the most primitive manner, what may we not expect of fishes when, without exciting their suspicion, we follow them patiently hour after hour?

In looking over the most recent faunal lists of this portion of the country, I find that the Delaware and its tributaries are credited with between fifty and sixty species of fishes. Some of them I know nothing about, albeit in one instance I am quoted as the authority for the presence in the Delaware of one such little fish. What there is in the books that more interests me is the fact that, of the fishes enumerated, forty-nine are found within the range of my quiet rambles about home. Of all that frequent these waters, forty-nine I am sure have names; and as there may possibly be others without names, I am always on the lookout for them, and also for those that may have wandered beyond the habitat assigned them by the systematists. Much of our zoölogical literature is, in this respect, somewhat amusing. By a preconceived notion of what should be the geographical distribution of our fishes, and other animals as well, these "systematic" writers gravely assert that in such a river such a fish is found, but that it never wanders either to the eastward or westward. Perhaps originally this was true of our rivers, as the river itself determined the range of specific variation that has ultimately come about; but no river could retain all the species that originated in it. There are too many possible ways by which fish can be safely transported long distances, for us to assert that none of them have operated in stocking a neighboring stream with species not native and to the manner born. There is undoubted evidence on record of whirlwinds gathering up immense numbers of minute fish and landing them safely miles and miles away. These showers of fishes, frogs, and even salamanders, are not unknown, even if they are uncommon; and strange would it be if all such wind-transported species should fall upon dry ground, and never into the water. Fertilized eggs, too, can likewise be blown a long distance, even over low ranges of hills which sometimes separate river valleys, and so give rise to a race of fishes that previously were unknown in the locality. Eggs, too, might readily adhere to the mud that often clings to the feet of wading birds, and would thus be gently replaced in a distant river, miles away from that in which they were deposited by the parent fish. The present extensive system of canals, also, has tended to mingle the ichthyic faunas of our various river systems. And when all these possible, probable, and actual conditions are considered, it need excite no wonder if in any one of our rivers or its tributaries we now find occasional individuals of unsuspected species.

In taking up the consideration of our several fishes separately, it will be well to follow some definite method, and therefore I shall treat them in the order in which they are named in the later systems. The one which heads the list, in a little hand-book by my side—Jordan's "Manual of Vertebrates"—is the "hog-fish"; and it is of this that I will first speak. Why it is so called I can not say, as it surely has neither the habits nor the appearance of any hog that I have ever seen. It belongs to a family of most curious fishes, known collectively as "darters," or etheostomoids, and I prefer to call this one the "sand-perch." These "darters" have been well described as preferring "clear, running water, where they lie on the bottom concealed under stones (not always), darting, when frightened or hungry, with great velocity for a short distance by a powerful movement of the fan-shaped pectoral fins, then stopping as suddenly . . . . All are carnivorous, and, in their way, voracious."

There are several species of these darters found in our streams. Of this I am well convinced; but I have not so surely identified more than two. Of these, the larger is the sand-perch. To find it, we must hunt some little bed of clean sand among the rocks of the river, and sharp eyes will be required to detect it, even when we are sure of its whereabouts. Here, resting on the sand, it remains "stock still," and one would almost think it dead; but let a shadow pass over it even, or a baby crayfish dare to come near, and, like a flash of light, both fish and little crustacean have disappeared. Often, when fishing for perch, I have leaned over the side of the boat, and, scanning closely every square inch of sand, have finally caught a glimpse of a sand-perch. The perch proper would be for the time forgotten, and the little etheostomoid, or darter, command all my attention. No matter if the sun did burn my neck, or the larger fish were biting eagerly: the chance was too good to lose, and down into the depths I would gaze while the little fish remained. If nothing eatable came by, the darter would be content to remain idle; but this does not long continue, for sooner or later some little speck, one could not tell what, would float by, and with a jerk, jump, twist, and wiggle, that speck had gone—so, too, the darter. This indeed about covers my knowledge of its habits—at least, so far as I have seen it in the river, for I know nothing as to where and when it lays its eggs. Under different and somewhat peculiar circumstances, however, I have several times met with this little darter, and these instances merit a moment's notice. With the incoming tide that makes up Crosswicks Creek, a score or more of these darters will often stray into each of the little depressions in the adjoining meadows which are slowly covered by the steadily increasing volume of water. These depressions are the faint channels through which the last ripples of the receding waters retire, and are often irregular from the little sand-ridges which the currents and cross-tricklings form, and also are often dotted with regular, cup-shaped holes where the cows have chanced to pass over the wet sand. At high tide all is serene, and the hungry darters gayly pass to "fresh fields and pastures new," confident of a goodly feast on the myriad insects that the encroaching waters have entrapped. But soon a change comes over the spirit of their realities—for, if fishes do not sleep, they can not dream—and all unheeding of the fickleness of the tide, they soon find themselves left, not high and dry indeed, but in the little treacherous holes and hollows in the sand and short grass from which the waters crept so stealthily that their suspicion was never aroused. Slowly, too, this lingering water is sinking away in the loose sand, and the burning sun above makes them all the more uncomfortable. "What shall I do?" each and every one asks, not in so many words, but by so many acts. Around the little shadow of a pond they jerkily crawl, but find no watery outlet. Then, as they quietly contemplate their fix, they find themselves, not short of breath, but of water, and, willing to trust to luck, they give a mighty jump, knowing that they can get in no worse position on the other side of the pitiless ridge of sand that surrounds them. Do they see the receding waters in the distance, as they leap over the sandy ridges and from hollow to hollow, or do they smell the water or hear it flow? At all events, they jump generally creekward, and soon find larger pools, and then still larger, until again they can swim, and away they scatter over the sandy bed of the beautiful creek that has served them such a trick.

The sand-perch can not always escape as easily as I have described. The birds have learned at last to know of the mishap that so often occurs to them, and the purple grakles, the red-winged blackbirds, the little bittern, and the fish-crows do not fail to hasten to the bared sands as the tide goes down, and cut short the career of these little fish while on their forced overland journeys.

Most curious of all, however, is the means adopted by some of the fish to escape the inconvenience caused by the treacherous tide and the attacks of the birds to which they are at the same time subjected. With a desperate wriggle they will displace a portion of sand, and burrow so far downward that they reach a spot sufficiently moist to sustain life, although without a drop of accessible free water. Here, patiently or impatiently, one can scarcely say which, they await the return of good times, of increasing waters, of jolly high tide. Perhaps they are not to be caught thus a second time, though it is possible that they may be; and, if so, why is not an occurrence like this the starting-point in a change of habits which will ultimately result in accustoming them to mud and sand, like the mud-minnow (of which more anon)?

The other darter, or sand-perch, common to these waters is a smaller fish, so small that its presence is often unsuspected. Like its cousin, the "hog-fish," it can not swim more than three or four "strokes" before it has either to come to a standstill, or at any rate put "one foot on bottom," as boys do when learning the same art.

While not averse to trying its fortune even in the river, this little fish—Olmsted's darter—wanders indefinitely up-stream, and no puddle is too small for him, provided it always holds water. They have no more fancy for a sun-bath than the preceding. Where I have found them in greatest abundance, is in a little shallow just off the main channel of the smaller creek I have mentioned in a foregoing page. There is here a muddy bottom, with a thin superstratum of fine sand upon it. No perceptible current flows over it, and the little darters, faintly marking the sand whenever they come to a rest, can be tracked by these little impressions. Here I have seen hundreds of them quietly resting on their leg-like fins and waiting, not for something to turn up, but to come near, when they are up and at it. They do not, however, depend on such a slim chance for a sufficiency of food, as they are as carnivorous as crocodiles and have the digestion of an ostrich. Their predilection for these quiet, watery by-ways seems to be brought about by the habits of other animals, which, bringing their food to these retreats to enjoy it at leisure, always leave innumerable fragments for the benefit of the darters. Indeed, these fish do not wait always for the crumbs that may fall from some mightier creature's table, as I have often seen them crowd around some happy turtle that had brought a fish or fragment of flesh to this shallow in order to dine in peace. The little darters, however, did not wait to be invited, but, standing at the other end of the fish or flesh, would give it little tugs and nips while the turtle was busily engaged in biting off larger mouthfuls. These darters are the most persistent egg-hunters anywhere to be found, and, in spite of the vigilance of the parent fish, will dart in and out and swallow the eggs that have been laid and placed with so much care. Many fishes so place their eggs that they are not accessible to the darters; but when laid in the sand, as the sunfish do, or among loose pebbles only, the darters can readily find them, and they quickly devour all they discover. Were it not for this unfortunate habit, these little fish would merit our kindly consideration, as they help, to a certain extent, in keeping pure the waters of the streams they frequent.

I have said there are but two kinds of darters in our waters. I meant but two of whose identification I was sure. There is, or was, a third. Some years ago, in a pretty stream, which my neighbors persist in calling the "Ten-foot Ditch," I found a few crimson-marked specimens, that were wholly unlike the others, playing on and in silvery white sand. The following autumn the crimson markings had become dull brown, but the little cylindrical bodies were of the same shape, and the ridiculous efforts of the little fishes at natatorial locomotion were just as absurd. A few of these I bottled, and they were pronounced to be the *Hololepis erochrous.* I was glad to find they had a name; but since then, ten years ago, I have been too busy to use it, and find that "crimson darter" meets all my needs.

Passing on, in two ways, to a new page of the faunal list and to deep waters, we come at once to what has always seemed, and really is, a model fish. It is complete in every feature, and there is nothing flabby about it, like a sucker or roach; nor is it out of date and clumsy, like a gar-pike. I mean the yellow perch.

So far as I have been able to follow it, this fish remains throughout its first year, and often for many years, in the stream in which it was hatched. Of course, where it happens that the ova has been deposited in some little out-of-the-way brook which grows smaller as the summer passes, then the young perch will find their way into deeper and cooler waters; but they do not wander far from their birth-place. For instance, many perch leave the Delaware, and, seeking out suitable localities in the tributaries that have an uninterrupted outlet, deposit their ova in such smaller streams.

This perch, then, may be said to be a strictly resident species. There is not a month in the year, or week in any month, when they may not be found. Not always are they so evidently abundant as in spring and summer; but they have not wandered far, and only a little closer search is needed to spy them out. If we go a-fishing only in the river, the impression of the rarity of yellow perch will soon become fixed in the mind; but this arises not so much from the actual scarcity, as from the fact that they do not bite at a hook as readily as when in the still waters of our ponds. The nets, however, tell the story, and prove that they are in the river, and abundantly too, in spite of the firm belief of the line-fisher that "there are no yellow perch in the river." When it comes to comparing perch with sunfish, on the other hand, it is evident that, however abundant relatively they are in any of the neighboring streams, they are far outnumbered by these less desirable percoids.

What the maximum size of a yellow perch may be is as yet undetermined. I never have seen a monster among them, but my neighbors report a supermonstrous one, and so I leave the question open. I have knowledge of one caught in the Delaware that weighed four pounds and a quarter. This I mentioned once in the fish-market; but the old gray-beards there sniffed contemptuously, and told marvelous tales of the wonderful size of the perch they had caught. Such fish, however, never get to market, and the tales need not be repeated.

The yellow perch appears to be equally at home in very different localities. As a still-water pond fish, if there is a fair supply of spring water, they thrive excellently; but the largest specimens I have ever seen were either from the river or from the outlets of the larger inflowing creeks. Occasionally they have been found in very shallow waters; but the attraction was very evident: they were following up the millions of small minnows which frequent all the smaller brooks. Indeed, with all our perches it is the story of the blue-fish and mossbunkers of our sea-coast over again. They chase the small fish upon which they feed even to such shallow waters that they are themselves occasionally entrapped. If not feeding, then deep water is preferred, and often I have seen numbers of them resting apparently upon the bed of the stream, side by side, and all with their heads upstream, just as, in August, one may see often a closely-packed mass of crimson red-fins in a deep pool of some rapidly flowing brook. Still, as such scenes are not common among the perch the year through, perhaps they can best be described as a semi-social fish. Without going in schools, as do the herrings, they are usually found together in considerable numbers, though this association perhaps results rather from the attractiveness of the locality than from any pleasure in associating with their own kind. This is one of those impressions that a close observer will sometimes get without being able to adduce any evidence of the fact. At all times these perch freely associate with other percoids in the same manner as with individuals of their own kind. Thus a single yellow perch will often be found with a school of white perch or of rock-fish, or there may be a mixed company of the three kinds in very unequal numbers.

As the pursuit of food is the one prominent object of their restless lives, of course all the fishes of a given pond or stream, having like habits, will be brought closely together. While we find that hawks of different kinds will often quarrel when chance brings them together, and the same may be said of carnivorous mammals, it does not appear that this is the case among fishes. I have never seen anything on the part of any of our perches that indicated anger, and certainly never saw a "fight going on" among them. Fish generally are very playful; but this never ends in a row, so far as I have seen.

A far more interesting fish than the preceding, because there is a mystery about its breeding habits, is the rock-fish, striped bass, and "streaked snapper," as this percoid is variously called. For years I thought I knew this fish thoroughly, but it seems not—at least, so far as being able to say when and where it breeds; but of this hereafter.

Nearly two centuries ago Gabriel Thomas mentions *Rock* among our fishes as one of the goodly sorts that acquired great size. This is true of them still; but it is not common now to find them weighing twenty pounds or more. It is accounted now good fishing to catch many weighing twenty ounces. Even longer ago, one Mahlon Stacy, who settled the spot now called Trenton, recorded his fishing experiences, and, in the course of that account, he says: "We have great plenty of most sorts of fish that ever I saw in England, besides several others that are not known there, as *rocks*, cat-fish, shads, sheep's-heads, and sturgeon." This is the earliest reference to the fish in the Delaware that I can find.

At present the rock-fish is found not only in the river, but in such inflowing creeks as have water sufficient for it to swim. When very young it delights in wandering into little streams to catch the myriads of small minnows that congregate in the eddies of every brook.

Just as the larger fish feed upon shiners in the river, "at the turn of the tide," so too do little rock-fish, scarcely two inches in length, gather about still smaller shiners, and capture them as dexterously, and devour them as voraciously, as ever did an adult fish. Prior to the erection of the dam near the mouth of the Assunpink Creek, at Trenton, the rock-fish ascended this creek, as I found bones of this fish in considerable quantity in an Indian shell-heap three miles above the outlet. It still passes up Crosswicks Creek in large numbers, entering it at Bordentown, and going as far as the dam at Groveville; and if I were not assured of the contrary, I would say that these rock-fish spawned in this creek. It seems, however, that such is not the case. In the course of a day's ramble, March 2, 1879, I met with an experienced fisherman, and questioned him closely about these fish. Here are his words, taken down while he was talking:

"The young rock-fish are very common, from one to three inches long, in shallow water along the river shore, where they swim about with little minnies, on which they keep a-feedin', sometimes eatin' a fish as big as themselves.

"The old rock-fish keep goin' up the river from early spring until late in summer, and in October and November, accordin' as it is a late or early fall, come down the river in large numbers. In winter, or very early in spring, they are often found in deep holes in 'gangs.' In a hole near Newbold's Island, with one drag of a net in a deep hole, one hundred and fifty weight were taken, rangin' from five to seventeen pounds weight. I never saw a rock-fish with roe in it, as I remember, but young ones are common so small that I'd a supposed they were hatched here in the river. Perhaps they go down to the bay, and the young come up from there, like as we see the young eels a-doin' in spring, when the stones are black with 'em often."

This is what I got from a professional fisherman, who, to again use his words, "had fished these waters about here for just fifty-seven years come next summer."

I had based my impression, that the rock-fish bred "in these waters," solely on the evidence of young, apparently too feeble to have come from such a distance—fully one hundred miles; but it seems they did come from somewhere down the river. At all events, they get into tide-water creeks very early in life, and, as the old fisherman told me and I have myself noticed, they remain here pretty much the year round. Still, we can not call them resident species in the sense of non-migratory fishes. This they are not. Possibly no one individual remains very long in one locality, but no sooner does one depart, than another takes its place. Like the robins among our birds, they are restless and wandering, but not methodically migratory.

The food of the rock-fish consists exclusively of small shiners or cyprinoids; and it is the pursuit of them into small streams that explains their presence in places where one would hardly expect to find them. A rock-fish will frequently "corner up" a small school of shiners, and then pick them up as rapidly and with as great ease as a fowl will pick grains of corn, and, while devouring the luckless minnows, it will keep them all the time huddled together in a small space. There is no cessation of this murderous work while a shiner remains, for, after devouring all that it is possible for it to eat, a mere love of destruction keeps the rock-fish still at work.

I once had a very favorable opportunity for watching one of these fishes feed in this manner. It was of moderate size, being about twelve inches in length. As nearly as I could determine, it devoured twelve silver-fins—a fish about three inches long—in four minutes. If I err in my estimate, it is on the safe side, as it may have been fifteen that were devoured in that length of time. Subsequently I captured a dozen of these exquisite minnows, and found that I could not squeeze them into a mass of the size of a rock-fish one foot in length; and yet the fish did not appear to be distended. I can only explain this by the fact that each fish, as swallowed, was compressed in the murderous jaws of its captor; and, being somewhat mangled, such fishes would lose a fraction of their bulk.

A third perch, but one which no longer reaches the size that it did in the days of our grandfathers, is the well-known white perch, or "river-bass." As a little fish, measuring but an inch or little more, it makes its appearance in the river in schools of thousands. Preying upon the equally abundant minnows of the same stream, they grow with great rapidity, and by August are very gamy, and large enough for "pan fish." This is the brief, prosy history of a splendid fish.

Years ago I was satisfied that both the white perch and rock-fish spawned in the clear, cold, upper waters of the river and in certain of the tributary creeks. This, it seems, is not the case. Just where they breed is a question not yet answerable; but the "somewhere" is at some distance from the supposed spot, and the little fish, newly hatched, or at least comparatively young, come up the river early in spring, and, once here, remain for more or less time, according to the character of the season, abundance of food, and other causes. One point, however, in their habits needs to be dwelt upon in this connection: fish with well-developed ova are frequently found in the river in May and June. It is now thought that these ova are carried until late in autumn, and then deposited on the accustomed spawning-grounds, supposed to be somewhere in the lower bay.

Both the rock-fish and white perch, then, must be classed with the migratory fishes, and therefore are widely different from the yellow perch, which is a resident. This can live and thrive in any pond, and exhibits little taste for extensive rambling, at least as compared with the others.

Both the rock-fish and white perch, nevertheless, can be "land-locked," and individually they will thrive in this condition if provided with unlimited food. That they would breed, when thus "land-locked," is doubtful.

The latest results of studies of pickled "sunnies"—a shapeless mass of faded and distorted fish, half preserved in weak alcohol, or bleached and bent by too strong spirits—is that in the Delaware valley there are eight species. Of these some are unmistakable, for among sunfish, or *Centrarchidæ*, are included the black bass, goggle-eyed perch, the mud sunfish, the "copper-bellies," as well as the "sunnies" proper, all of which are familiar to every boy in the country. About one or two so-called species we need not now concern ourselves, as they float in pickle, but do not swim in fresh water; and it is only with those that can be found any day in the week that we are interested.

However, let us follow the faunal list in the manual at hand, and consider *seriatim* some of our sunfish proper.

Heading the list is a most interesting and well-defined species, the mud sunfish.

In one of my neighbor's meadows there is a deep ditch, which a century of freshets has widened and deepened, until now it has all the appearance of a spring pond. A growth of birches hides it from view until we reach the very shade of the trees, and all the summer the water is quite concealed by a marvelously rank growth of splatter-dock and white lilies. Upward from these lily-buds and dock-leaves extends a slimy black log, that is now worn as smooth as ebony by the friction of turtles' feet and shells; for here every day throughout the summer rest all the turtles that can crowd upon it. The banks of this pond or ditch are steep and high, of a stiff clay, and burrowed through and through by the colony of muskrats that are known to dwell here, but which are seldom seen, and are too cunning to be caught. Much as there is here, in broad daylight, to be seen and enjoyed, I often pass all by, and drag a scoop-net among the weeds, in the expectation of making some rare "finds." Nor am I often disappointed. Among the curious objects I bring to light from these weedy depths is this mud sunfish. Dull brown and black, with gilt, green, and bronze reflections, it is a pretty fish, seen at its best, and one worth careful study. A glance shows that it is unlike the ordinary sunfish. Longer in body, with more spines in the fins above and below, and a generally bass-like appearance, it gives the impression of a gamy fish, and this it really is.

Inasmuch as all fishes in the breeding season are more interesting than during the other eleven months of the year, it is desirable to know all about them in this particular month. So far as I am concerned, this month will have to be passed over in silence. I never could find their nests, although I have stirred up acres of mud in search of them. Stranger still, I never could find any very young specimens — none that were less than six months old. Certainly, the mud sunfish is cunning in hiding her nest and eggs, and the young fry know well how to keep out of the way. As other desiderata in zoölogy have been gathered up when least expected, so, too, in this case I suppose I shall stumble across the nest and young some day when looking for other objects.

That the spawn is deposited in spring is evident from the condition of the females in April. In May, too, I have noticed that the metallic luster of the male fish is more marked than later in summer.

In February, 1875, I placed three fine specimens of this fish in a large aquarium. The colors of the two males were then very bright, and it seemed as if they were aware of the fact, as they moved about in a stately manner, endeavoring, I believe, to attract the attention of the female. Except on such occasions, these fish are dull and listless. I noticed that my aquarium specimens much of the time assumed a perpendicular position, head down and tail up, in a bunch of river-weed. The fins were without perceptible motion. One of my specimens retained this head-down and tail-up position for forty minutes, and, when driven from his bunch of weed, swam about very listlessly, resuming this strange position as soon as I would let him. A curious freak in coloration also was noticed at this time. Occasionally I would go to the aquarium and find every tint had paled into an indefinite dull yellow. Not a trace of metallic luster remained, and even the black bands were at best but a dull brown. Forced exercise, however, brought back the color. At such a time I would cause them to swim rapidly from end to end of the tank, and the result was a restoration of the normal tints. It proved to be with them, as with children, that a good lively romp brings a deeper glow to the surface. This sudden change of color in fishes is of much interest in connection with the subject of sexual selection; but as this fish is nocturnal in its habits, I can scarcely believe that on this one occasion in the year, when it is active and abroad by day, it is seeking the clearest water and direct sunlight for the better display of its peculiar metallic tints. Certainly the fish does not require this particular coloring as a means of protection, for it has now no enemies. The significance of the color is not known; but the fact that the fish has some control over it, as the deepening and fading out clearly shows, leaves no room for doubting that it has some important bearing on the habits of the species, and that it is of great influence in the courtship of fishes is therefore highly probable.

During succeeding summers I have several times floated over weedy patches in the little creek near by, and detected mud sunfish resting in the river-weed. It was the same old story of my aquarium specimens. In every instance these fish were in the remarkable position I have mentioned; not, indeed, in every case perpendicular, but always closely approaching it, and with the head downward.

I once had the good fortune to observe a large specimen of this fish making its way toward deeper water through such a dense mass of aquatic vegetation that the greater part of the time it was actually out of the water, apparently creeping among the weeds by the aid of its ventral fins. It progressed in this awkward manner fully three feet, keeping the body in a position as nearly upright as when swimming. On subsequent examination I found that a large log was deeply imbedded in the mud, with less than half an inch of water flowing over it; and it was this barrier that caused the fish to imitate successfully the reptile-like movements that I had witnessed.

Like most fishes that habitually frequent weedy and muddy waters, this sunfish is really nocturnal in its habits, and it is for this reason that it is so little known. Like all other nocturnal fishes, too, it has a well-developed voice; but of this hereafter. In a subsequent chapter this subject will be treated of at length; and the mud-sunfish will again come under our notice.

CHAPTER XXXV.

BRIEF NOTES ON FISHES.—(CONTINUED.)

The next sunfish mentioned in the "Manual" as one of the Delaware River species is that known by me as a "brass-belly." My angling friends always call it the "river sunfish," and this name covers an important fact in its history. It is emphatically a river species, and very seldom wanders out of it. Years ago, when I first dared go a-fishing, my companion, whom I looked upon as a second Cuvier, once suggested that we go to the river for "brass-bellies," and the success of the day's fishing was such that I have never forgotten it, or the name that Bob gave these sunfish. Then, too, on our return we were met by a colored fisherman of great experience, who paused to admire "the string" we were carrying homeward, and he corrected my companion by asserting that we had caught "big-ears," and not "brass-bellies." However, I was not convinced, and I still adhere to the name given them by my companion, though the other is equally descriptive and more refined. In considering the significance of color with reference to the preceding species, it will be remembered that two facts were prominently noticed in regard to the mud sunfish—the absence of conspicuous coloring and its nocturnal habits. In the case of the "river sunfish," or brass-belly, there is, on the contrary, very conspicuous coloring, and its habits are diurnal. It has a green back, red vertical fins, and a bright yellow-red belly, with deep blue on the sides, blue stripes on the head, and a long, velvety black ear-flap. Now, the spring and summer through, this fish seeks clear, running water, and therein sports the day long, leading very much a butterfly-like existence.

In April, the colors, always bright, are more brilliant than ever, and it is at this time that it becomes evident that the fish realizes what color is, and puts to good use all the attractions that sexual selection has evolved. Seeking some female of its kind, it displays itself by a series of graceful manœuvres, which are highly entertaining even to outsiders. Passing to and fro before the desired female, the fish will at times swim upon one side so that the sunlight will strike directly upon the brilliant blue and crimson hues, and then, suddenly regaining its ordinary position, it will spread all its fins to their utmost and sail majestically by, giving the spectators the impression of a larger fish than it really is. This is kept up, I think, for several days, and, if not interrupted by the intrusion of a rival, results in a graceful acceptance. Here I am puzzled, for, as often as I have watched these fish, I never could detect any movement that would warrant me in interpreting it as a sign of acceptance. Indeed, it is highly probable that they have means of communicating ideas by movements so slight as to escape our closest scrutiny. In the spring of 1873 I noticed one of these river sunfish endeavoring to make a favorable impression upon a female. Whether she paid any attention to the nervously active gallant, I can not tell; I only know that she remained stationary for hours, while the male passed up and down, and from side to side, almost as steadily as clock-work. If disturbed, away they both would dart, but only to return in a few moments, each to resume its former position, the one being apparently a quiet spectator of the graceful submarine gymnastics of the other. This continued from Sunday until Wednesday, when both fish disappeared, and were found soon after building a nest some fifty yards distant.

Like all nest-building fishes, the river sunfish is very pugnacious while it has a nest under its care, and will defend it against every intruder. Not always is it successful in this, I am sorry to say, but it is never cowardly, even when turtles and snakes invade its retreat. Indeed, I have seen a red-bellied turtle seize the sunfish, when too bold in its attack, and tear it nearly to pieces. The worst enemy, however, of the sunfish at such a time is one of the little darters, already mentioned, which rushes in among the eggs without being noticed, and then is off and half-buried in the sand before the harassed sunfish can arrest him.

When the young fish are about one third of an inch in length—and about as broad as they are long—they are left to shift for themselves, and they are quite equal to the demands made upon them. What they find to eat, I can not say; but their quick movements, as they dart restlessly about, clearly show that they find something, and know how to secure it. The young fish of each season remain together for a year or more, and only become widely separated as their steady growth demands more extended feeding-grounds. This requires each brood finally to scatter; but if sufficient food were at hand, these fish would probably remain in close companies, as they appear to be a very social fish. Certainly, mated fishes possess a strong mutual affection, and many instances have occurred under my own notice that indicated this most unquestionably. I have further proved it by cruel experiments, which will be mentioned hereafter.

Occasionally the allied blue sunfish, or "copper-nosed bream," has been found in the Delaware. The first of these I found in 1874, and since then I have seen but two, until last August (1881), when one was caught in Crosswicks Creek. Somehow, through the canals or otherwise, these fish have reached our river valley. Here they are, and this is all I know about them.

The common sunfish, *the* "sunny" *par excellence*, is next in the list. How many entries in my note-books refer to this fish I have not time to count; but I never went to Watson's Creek without seeing hundreds of them, and never came home that I didn't "put it down." It was not, however, always a mere sight of the fish, and nothing more, as I sometimes had glimpses of its habits, and followed it up until I learned some new fact. Such days were not lived in vain.

It happens that at what is called the "bend" in Watson's Creek there grows an enormous elm, the gnarled and twisted roots of which extend out into the clear water—clearer for the spring that here bubbles up from the bed of the stream. Given this combination of creek, spring, and tree, and the fourth feature, a pair of sunfish, is not likely to be wanting. At all events, in this case there is always a patriarchal sunfish and his mate living in state among these elm-roots; and a very interesting fact is here to be noticed at the outset. They are not merely paired for the season, but remain a faithful and loving couple all the year and for several years. One such pair did so live, I know, and I believe the same may be said of them all, at least when they are large enough to gain possession of some such nook as I have mentioned and can hold it against all intruders. Their worst enemies are men and boys, of course, for juvenile anglers in particular are prone to find these aged "sunnies," and exercise all their ingenuity to capture them. Here comes in the evidence of affection on the part of these fishes. If one of them is hooked, the mate is at once aware of the fact, and is prompt to seize the same fatal hook, as though unwilling to be left alone and anxious to follow its companion even to death. Why, it may be asked, is it not a simple case of "good luck" on the part of the angler? Two fishes were in the same "hole," and both were caught—the same bait that deceived the one deceiving the other. This is a rational explanation of such an occurrence; but, in my own angling experience, I have found that it is only by great care and much ingenuity that these large fish can be induced to bite; then, if one is hooked, the other follows it to the surface of the water, and is evidently excited and distressed, and, unlike its unfortunate mate, bites savagely at the hook as soon as it is replaced in the water. It seizes the hook either in revenge, or because it realizes that by so doing it can follow its companion. I consider the facts of the movements of the two fishes—the wariness of the one first captured, the recklessness of the other—and deduce from it that the psychology of fishes is no myth, but that in such an instance as here given there is evidence of distrust, and of anger, revenge, recklessness, and deep affection. These traits—one shown by one of the fishes, and the others by its mate—lead me to conclude that the life of a fish is by no means a mere mechanical, joyless existence. In fact, one need but look straight into the eye of a large pike, to be satisfied that that fish is every whit as wicked in his thoughts as he is in appearance, for pike *do* think, as every one who has angled for them will, I think, admit.

To see our common sunfish at their best, it is necessary to hunt up their nests in May. Then everything concerning them is intensified. Their colors are brighter, their movements more active, and every feature of their surroundings is furbished up and new. The mud of the spring freshets has all floated away or settled to the bottom of the pond; the water-plants are not too rank to conceal the fishes' haunts; and the foliage of the overhanging trees is fresh, bright, and not too dense for straggling sunbeams to penetrate. One of the "sights" at this time, if we direct our steps to the creek, is the row of sunfish-nests along the shore. This fish at this time has a horror of dirt, and every speck other than fine, clean sand is carefully removed from the shallow circular depressions which constitute their nests. Now, it often happens that the available places for such nests are not everywhere along the bank of the creek, but that short stretches, here and there, only can be utilized. These are fully occupied, the nests being at times but a foot or two apart; and, when a comprehensive glance can be had, they look like a row of rusty pie-plates just beneath the water. In these nests both fishes will often be, and yet scarcely recognizable when seen from above. All the gorgeous coloring is confined to their sides and bellies; the back, being a dull green, blends well with the surroundings and the color of the water. This fact would afford them protection from such enemies as might be above them, though there are none such now, unless, perhaps, a stray otter or mink might happen to be near. Doubtless, in the long ago of primeval forests and abundant wild-cats and fisher-martens, this green color was of much value to sunfish as a protection against surprise; but that time has long passed, and now their enemies are gone, except the pin-hook and tow-string anglers of recent times, though these again are generally too bungling to be dangerous. The nests are usually occupied for a space of four weeks, when the parent fishes relinquish their cares, and leave the young "sunnies," now more like flakes of jelly than bony fishes, to shift for themselves.

One curious feature of the habits of sunfish, while nesting, is worthy a moment's notice. I have mentioned that often many nests are in a row and near each other. The occupants of the several nests do not molest each other, and never intrude beyond the limits of their own "homes." They have but one direction open to them, and this is to the deep water directly in front. Into this, when they leave the nest, the sunfish dart with great rapidity. Often this constant going and coming wears a path along the mud and through the weeds, which can be readily traced for some distance. The return to the nest is as rapid and direct as the exit. Each fish, wherever it may go, has some point which is recognized as the terminus of the lane leading to the nest, and, having found this, it speeds up the narrow pathway with incredible velocity, and stops as suddenly just at or in the nest. Then the other, as quickly and in the same manner, departs, leaving the nest in charge of its mate.

Here we have evidence of the "sense of direction," which is very remarkable. There is usually a dense growth of pond-weed or splatter-dock between the nest and the channel or deepest water of the creek or pond. How, when the parent fish is in this clear, deep water, it can tell the exact position of its nest, and swim directly to it, is a mystery; yet this they are unquestionably able to do. However well defined the pathway or lane leading from the nest may be, it necessarily "fades out," as it were, as the deeper water is neared; but it would seem as though there were some landmark that the fish recognized. If this is not the case, and it is difficult to believe, may we not ascribe to them the possession of a so-called "sense of direction" working independently and unerringly, without regard to any features of the surroundings? Such a sense, indeed, the sunfish seems to possess. The possession of a sense of direction is also shown by such experiments as the following: I once carefully removed a sunfish from its nest, and carried it one thousand feet *up* the stream, when I set it at liberty. Between the nest and the point where I placed the fish there were two abrupt bends in the creek, so that it formed a letter Z between the points mentioned. I hastened back to the nest: but the fish was there before me. I then took a fish from an adjoining nest, and carried it nearly one thousand yards *down* the stream. In this case there were two bends in the stream, and it was also partially obstructed by old abandoned flood-gates. I hurried back to the nest, and reached it only three minutes before the fish returned. I have since made many similar experiments, and all with essentially the same results.

When nesting, the fact that fishes are affectionate can be readily proved; but the experiment is cruel, and I trust will not be tried. It is merely to hook one of the nesting fish, and, when dead or dying, place it in the nest. I tried it once, and will certainly never repeat it. The evidences of grief on the part of the distressed and bewildered widowed fish were truly affecting.

A few words with reference to this fish as a weather prophet. The old men of the neighborhood frequently speak of them in this connection, and undertake to foretell whether the coming summer will be wet or dry, from the fact that their nests are sometimes in water a foot in depth, while at others less than one half this depth covers them. These wise old men of the village sagely shake their heads, when the facts are stated, and remark, if the nests are comparatively deep, "It will be a dry summer," and *vice versa.* This is based on the supposition that in dry summers the evaporation will exceed the rain-fall, and that the fish place their nests in deep water to prevent them from being left high and dry. The absurdity of this is apparent. The nests are occupied but for a portion of one month, and what the summer may be can in no wise affect them; but of this the village sages never think. The truth is, the same spots are used year after year, whether the water be high or low.

In those of our shallow, sluggish waters which have an indefinitely deep, muddy bottom, and harbor a rank growth of aquatic vegetation, the handsome, silvery, black-banded sunfish is a common species. In such localities, where often the weeds grow so luxuriantly that a scoop-net can not be drawn, I have found that hundreds of these fishes were passing what I think must be a most monotonous existence. In some places, locomotion must be rather a scramble among the water-weeds than a comfortable swim. Still, these spots have their advantages; for the stems of the plants harbor myriads of minute forms of life, and these constitute a never-failing supply of food for the fishes, as may be proved by an examination of the contents of their stomachs, and by a study of their habits in an aquarium, where these same forms of animal life were supplied.

Recently I submitted a series of specimens to my friend, Dr. A. C. Stokes, of Trenton, N. J., who kindly examined the contents of the stomachs of these species by the aid of the microscope, with the following results:

In the stomachs of a dozen or more adult banded sunfish he found Chironomus larvæ very numerous; *Cyclops quadricornis* numerous; Daphnia sp. numerous; chitinous parts of small insects present, but not abundant; diatoms, desmids, and fragments of algæ, probably accidental; and a single rhizopod (*Centropyxis aculeata*). In very young fish he found Chironomus larvæ few, and *Cyclops quadricornis* and Daphnia sp. numerous.

He adds, "In the stomach of a full-grown fish there were from seventy-five to one hundred Chironomus larvæ, which seem to be the favorite food." This shows at a glance that the banded sunfish is essentially a surface feeder, and, as we seldom see them moving about in the open water or near the surface, they are probably nocturnal in their habits. In an aquarium, however, they seem to be as active during the day as at night, although averse to exposure to direct sunlight.

As a fish for the aquarium, the banded sunfishes are deservedly popular, and, indeed, they are better known as dwellers in such narrow quarters than as a prominent species in the fauna of the lower Delaware Valley. I believe they are not found above tide-water at all. I have frequently shown these fish to old fishermen, who rarely acknowledge that they have ever before seen them; and this fact is corroborative of what I had long supposed, that these fish are only found in out-of-the-way nooks and corners, where game-fish seldom if ever come, and that hence their haunts are not often invaded. In fact, one would scarcely expect to find any fish in some of the weed-grown holes in the meadows, where, in truth, scores of banded sunfish are quietly taking their ease.

Occasionally, however, I have seen this fish wander into quite open waters, and here it is that it shows to such advantage, when, with the brilliant black dorsal and pectoral fins spread, it moves majestically along.

Although so small, it is a plucky fish, and promptly resents any interference. Being a feeble swimmer, it depends for defense upon the sharp spines of its dorsal fins, and it seems to know that when these are erected it is quite free from molestation. Especially angry does it become when a great lubberly catfish chances to wander near by and pokes his slimy nose into its haunts. At once the plucky sunfish is up in arms, and darts at the intruder with great violence. It is a veritable case of the king-bird and crow over again, only beneath the water, instead of in the air.

I am still in the dark about the breeding-habits of this fish. At times I have thought that it scooped out a nest in the sand, as the common "sunny" does; but I am not so sure about it. During the spring of 1881 I found females of this species heavy with immature ova, and I am now of the opinion that, if any nest is made, it is in the mud, among the lily-stems, or at the base of some projecting root. Certainly, if anywhere in open water, I should have found them before this.

A puzzling fact, that haunted me whenever I went fishing, until very recently (September, 1883), was that I never found any very young "bandies," as I usually call them. I had often scooped up scores of the mud-loving Enneacanthi, found in the same quarters, but with never a "bandy" among them. Hoping ever for better things, I continued to search for them, and at last success crowned my efforts. Early in September last I found scores of little ones, some not more than half an inch in length. It is safe to say, therefore, that the ova are deposited in May or June. Just where, remains to be determined.

Years ago I stated in the "Naturalist" that the banded sunfish scooped out little basins in the sand, and therein deposited their ova; but do they? Upon the authority of what I stated in 1870, it has been repeatedly asserted that the banded sunfish is a nest-builder; but I am forced to admit that my own observations do not warrant me in going further than saying that this is probably true. Wherever one finds the banded sunfish, he is sure to find a few individuals of the common "sunny," and, when we consider the fact of the association of these species, how readily might it happen that the accidental proximity of a banded sunfish to a nest of the common species should lead to the impression that the nest was the possession of fish seen near it! I was possibly misled in this matter years ago. At all events, I am not positive I ever saw a nest of the banded sunfish.

A very constant companion of the preceding is a beautiful sunfish of about the same size, but very differently colored. It is known locally as the "spotted sunfish," from the blue and golden dots that are profusely sprinkled over the male fish. It has been given a variety of scientific names, and that which rightfully belongs to it, because first given, has been generally ignored.

I find in the hand-book that there are two of these spotted sunfish allotted to the Delaware, which, I doubt not, is all very true; but it is not always easy to tell which is which, if we follow the directions of the manual. One of the two has golden spots, and one blue spots—so it is said; but when I put one of them in a glass, I find the spots are blue one minute and golden the next, and so the change keeps on. Then we are told that one has cross-bars of black, and the other has them not; but this is only true in part, as the females of the spotted sunfish want the bars and spots, and the males have them: and so we could go on to the end of the chapter. If there are two species of these small spotted sunfish, then one is that named by Professor Baird *obesus*, the other called *guttatus* by Dr. Morris years ago. I well remember the specimens the doctor caught, and christened as above, and these are the same that, associated with the banded sunfish, are so common in all the weedy portions of Watson's Creek.

In a recent number of "Harper's Magazine" (December, 1883) Mr. C. F. Holder speaks of this sunfish as lying "dormant till the coming spring." This does not accord with my more recent observations. On the approach of cold weather, the fish that I have studied simply withdrew to deeper waters, and, wherever there is a lively spring in the bed of the creek, there these fish congregated in great numbers. Like the larger fishes of the same creek, they find open water somewhere, and there remain; and nets set under ice, in the depths of winter, show that very nearly all our fishes are active. Even the delicate cyprinoids are "moving," for, in the stomachs of pike caught in January, I have found remains of "shiners" of several species. I believe the hibernation of sunfish to be an exceptional occurrence, rather than a rule.

Like the preceding, the spotted sunfish is strictly carnivorous, but does not feed upon the same forms of minute life. This is shown by the results of my friend Dr. Stokes's careful examination of the stomach-contents of a series of specimens submitted to him.

The examination of twelve adult specimens of spotted sunfish resulted as follows:

In every case the stomach was empty, but the intestine contained tracheæ, eyes, elytra, heads and chitinous parts of small aquatic beetles. These were very numerous; also Pisidium sp. occasional; several small univalve mollusks; a few Chironomus larvæ; occasionally a Daphnia and Cyclops; and Gammarus sp. numerous. In the very young spotted sunfish examined, there were found Pisidium sp. occasionally; many Daphnia and Chironomus larvæ; a few fragments of insects; many Cyclops; a few very small univalve mollusks, and a single water-mite.

Here we have evidence that this species of sunfish is a bottom feeder, and resorts to the mud rather than elsewhere for its main food-supply; but not always, for, during a recent ramble along Watson's Creek, I noticed quite a commotion in the shallow water near shore, and, on approaching the spot, I discovered that three of these spotted sunfish had attacked a crayfish which had just cast its shell. The battle lasted but for a moment after I became a spectator. One by one the limbs of the crustacean were torn off, and portions of them devoured by the fish in full view of their tortured victim.

When I see such sights as these—and they are by no means uncommon—I can not but think that there is a screw loose in nature; that nothing is perfect, and animal life is only reaching out toward perfection.

In 1873 I happened to catch a fine specimen of the "goggle-eyed perch," and found, on inquiry, that it was a new fish in the Delaware, according to the systematists; and "oncommon," according to the experienced fishermen of the neighborhood. I showed it to several old "shad-men," and they all told me that occasionally they had seen them. Since then I have seen perhaps a dozen specimens, all from the river, and hence I conclude that they have a claim to a place in the fauna of the river valley. That they were not here formerly is probable; but now, and for many years, there has been a practicable route open to them, through our canal system, to reach the Delaware from either northwestern or southern waters. In this way, most likely, they have managed to come. All the specimens seen were adult, and this leads me to expect that ultimately they will become quite numerous. They are worth angling for, if all fight as did the only one I ever caught.

There is yet another fish that I class, for convenience, with the sunfish, simply because I usually find them when looking for "sunnies," though in fact it belongs to a very different family. It is the "pirate," or spineless perch, which, by the way, I never expect to find, and which I certainly never have found, when on a regular hunt for them. That they are always in the deeper ditches I am certain, but they can easily dodge a scoop-net, and all day long they hide in such inaccessible nooks that they are safe. It was only by accident that I ever have bagged them, and so, with a light heart, I make a place for every such one in my aquarium, and sit down to watch how the ill-tempered fellow behaves in confinement. They are well named "pirates," as they are among minnows what shrikes are among sparrows, and are more pitiless even than the pike.

Recently I find the correctness of this view questioned by Professor Forbes, of Illinois, who has made many exhaustive studies of the food of fishes. He says my specimens "were doubtless forced to feed so largely upon fishes for want of food more natural to them, since, in their native haunts, fishes make but a small percentage of their ordinary food." As a matter of fact, while my studies of the habits of this fish were largely confined to specimens in aquaria, these were supplied with other food, and my conclusions were verified by subsequent examinations of the stomach-contents of many specimens. I have frequently found them with a partially digested fish projecting from their jaws; and fish-remains proved to be fully seventy-five per cent of the contents of the stomachs of a series of seven adult specimens taken last September (1883), and carefully examined to determine the character of the food.

Professor Forbes further states that the "intestine of this species is short and simple," and overlooks the significant fact that it has a row of a dozen or more pyloric cæca, which doubtless compensate for the want of length of the digestive tract proper.

Without questioning the correctness of my friend's investigations on this point, I am quite sure that the cannibalistic appetite of the New Jersey pirate perches has not been overstated.

As a result of many long studies of them, in aquaria, I find that they are strictly nocturnal in their habits. Many fish, as eels and catfish, are essentially so, but in this case it is absolutely so. In confinement I never knew them to move about in search of food, although they were prompt to accept it if placed directly before and very near them. One large specimen, in particular, which I kept for eleven months, remained during the day under a little arch of stones, and so seldom varied its position that it became as permanent a fixture in my mind as the arch itself. I would scarcely have felt more surprise to see the arch change its place than to have seen any voluntary movement on the part of the pirate during the day; but, on the approach of evening, the fish began to grow restless and moved slowly to and fro, but not beyond the cover of the arch. Once let it be dark, and the restlessness gave way to a disposition to roam about, and this it did in an erratic, nervous manner. The result of its short journeyings, however, was invariably the capture of a good-sized minnow, and with this it promptly returned to the arch and resumed its favorite position. Usually it captured a minnow far too large to be swallowed whole, and so, with the tail projecting from its jaws, the pirate would go to the arch, and remain perhaps all the next day with its mouth distended by the projecting tail of the minnow it had swallowed.

As in the case of the banded sunfish, I am not positive as to the breeding-habits of this fish. In the "Tenfoot Ditch," in my neighbor's mucky meadow, I found early in June, 1860, very young specimens, which were thought to be but three or four weeks old at most. The water here was clear, with a swift current, and the bottom of the stream was completely covered with pondweeds of several species. Somewhere near, the eggs must have been laid; but where, or how many, is a matter of conjecture. There were not many of these young fish.

From circumstances connected with the finding of very young "pirates" in a nameless brook flowing into Cooper's Creek, Camden County, N. J., and later of finding very many associated young fish in the Shabbaconk Creek, I was led to believe that this fish made a nest like that of the common sunfish, and often appropriated the nests made by the "sunny." So sure was I of this, that I made an unqualified assertion to that effect in the "Geology of New Jersey," Appendix E, p. 808, and since then in "The Naturalist"; but of late years I have not been able to verify this. I can, however, speak very positively of the fact that the parent fish remain with the young for a considerable time, apparently to guard them; or was it to devour one occasionally, other food being scarce?

In speaking of the nests of the common sunfish, Mr. C. F. Holder, in the article I have already quoted, refers to the nesting habits of the "pirate" as follows:

"They have, however, one enemy that seems to defy them, the pirate perch (*Aphrodederus Sayanus*), which, like the cuckoo, that is either incapable or too lazy to build a nest of its own, often deposits its eggs in that of its neighbor.

"The perches wait until the sunfish complete their homes, when they evict them by force of blows, often only after a sanguinary struggle. This accomplished, the victors, male and female, install themselves, and the eggs are deposited frequently among those of the former occupants, who perhaps are avenged, as their captors guard their nest jealously, protecting the young sunfish as they come out, and staying by them until they are about half an inch in length, when they are left to look out for themselves."

Unfortunately, this statement is based upon my own perhaps too hasty conclusions, and may not be wholly correct.

Whenever I chance to walk along the tide-water ditches of the lower meadows, my attention is sure to be called to the greenish-gray minnows that dart by in scores, and in fact are only noticeable from above when seen in considerable numbers closely associated. They are of no particular tint as seen in the water, agreeing in this respect with the sandy, muddy bottom of the ditch they are in. To test this, I have often scattered a little school of them, and while none were concealed it was only with great difficulty that I could detect individuals; yet probably there were three or four on every square foot of ground examined. This indefinite coloring proves an excellent protection, or else the herons must have sharp eyes, for these birds catch as many fish as frogs, I think. These minnows are not the little shiners that are also called by this comprehensive term, but are the blunt-headed, square-jawed, barred little fish that are more common in the river than anywhere else, but are by no means confined to it. They are known scientifically as the *Cyprinodonts*, or toothed minnows.

I have gathered four well-marked species, but detected no differences in their habits. They are all social, carnivorous, restless, diurnal, running-water fishes, and seem to have no other duty in the plan of creation than to feed on minute mollusca and insect larvæ, and to hold themselves in readiness to be eaten by larger fishes, and by the king-fishers, the herons, bitterns, and other birds.

One of the four species, the common barred minnow, is of a more restless disposition than the others, and wanders as far from tide-water as it is possible to go. I know of no more earnest explorer among our many fishes. Wherever there is an inch of moderately clear water, there the barred minnow will be found. Only perpendicular falls of a foot or more in height, or constantly muddied waters, obstruct their course. Ordinary rapids, as where the water rushes madly over or about large rocks, do not prevent their onward progress; and often, early in the spring, I have seen them leap several inches up a fall that was nearly or quite perpendicular.

In general appearance quite like the carnivorous or toothed minnows just mentioned, is an abundant species that frequents only the quiet muddy ditches, mostly beyond the reach of the tides. This is the mud-minnow. It is a small fish, seldom being found of a greater length than three inches; but has been known to reach nearly twice that size. Such large specimens, however, are exceedingly rare.

In calling this fish the mud-minnow, it must not be supposed for a moment that they are sluggish, slow-moving creatures. On the contrary, they are as active as other minnows, and, being possessed of greater strength, can pass through soft mud with as much ease as other fishes do through the clear waters. Zadoc Thompson, in his "History of Vermont," speaks of them as very tenacious of life, and says they "can live longer than most fishes without water. During droughts, as the waters subside and recede from the coves, they have the power by a springing motion of transporting themselves from one little puddle to another. They also have the power of partially burying themselves and living in the mud and among the moist grass-roots, after the other small fishes associated with them are all dead from the want of water. In these situations vast numbers of them are devoured by birds, musk-rats, and foxes." This coincides with my own observations, except that, unfortunately, we have no foxes to devour the superabundant minnows.

One feature of peculiar interest in this fish is the great variation of color. While nearly all our dark-hued fishes differ in the depth of coloring, this variation is either permanent or it is in a measure dependent upon the season, as when colors are heightened by excessive vitality during the breeding-season; but in this case it is wholly different. Specimens kept in an aquarium, where the surroundings closely imitated their natural haunts, never exhibited uniform coloring. In many females the body below the lateral line was often glossy black, relieved by minute silvery dots; but frequently this color faded to the general hue of the back, which is a dull, greenish brown, in the larger specimens relieved by darker vertical bands. The most marked variation was in some of the smaller specimens, which were almost silvery in color below the lateral line, and pale, greenish gray above. The dark vertical band at the base of the tail is always present. No published description of the color will apply to one in a hundred living specimens.

During the winter of 1873–'74 I had unusually favorable opportunities of studying this minnow at this time of year. In December, while the weather was cool rather than cold, with but little ice, I found that hundreds of these fish were being thrown out with the mud then being taken from the ditches in the meadows. Learning this, I carefully examined the mud thrown out, to determine as far as possible the condition of these fishes. They were, when taken from the mud, motionless, stiff, and apparently frozen, though they were not brittle, and an attempt to bend them resulted in prompt resistance, or at least in voluntary muscular movements. Specimens thus roughly handled were, in most instances, injured by being thus bent, even when this curvation was not in excess of what they can and readily do assume in their normal condition.

On placing specimens in clear water of the temperature of 60° Fahr., they did not fully revive until after lying on their sides at the bottom of the vessel for from twenty-five to forty minutes, and then they seemed to be permanently injured by the sudden change; but when placed, with the mud still adhering to them, in water at 40° Fahr., and this was gradually warmed by the heat of the room in which the vessel stood, the minnows would become wholly themselves again in from ten to fifteen minutes, and swim about in full vigor as the mud slowly loosened from them and settled to the bottom of the vessel.

The mud in which these minnows were hibernating, when taken from the bottom of the ditch, was about of the consistence of cheese, though, of course, it was less firm when the fish entered it, weeks before. As far as I was able to determine, the fish had burrowed tail-foremost to a depth of from four to nine inches. In every instance I am sure the tail was deeper in the mud than the head, the position varying from nearly horizontal to almost or quite perpendicular.

Pursuing the investigation somewhat further, I found that when these minnows had gone into winter-quarters in water from three to five feet deep, the hibernating slumber was not as profound; and when they were placed in clear water, at a temperature of 40° Fahr., they almost immediately swam about, slowly at first, but with steadily increasing activity, and in from three to five minutes they were in full possession of all their locomotive powers, and assumed the statue-like positions common to them in summer, when for many minutes together they will remain immovable until an opportunity is offered to capture an insect or some minute crustacean. It should be here mentioned that the water in the ditches from which I gathered my first specimens varied from nine to fifteen inches in depth, and was coated with ice one inch thick.

During February, the weather being mild and spring-like—frogs singing at midday—I watched for the appearance of these fish, and saw them first on Sunday, the 15th. A week later, Monday, the 23d, there were but few specimens in the muddy ditches, but a vast number of females, heavy with masses of ova, were found in the swift, clear waters of the hill-side brooks.

On the 25th there was a violent snow-storm, with cold northeast winds, but this did not deter the onward movement of the minnows. Of the specimens taken from the rivulets at this time, none were males, and it seems probable, although I could not ascertain the truth, that the male fish follow the females, and, seeking out the deposited ova, fertilize them; or the females wait until the arrival of the males before depositing their eggs. While as yet this is largely conjecture on my part, I have not in subsequent observations seen anything to contradict it. Certainly the females precede the male fish to the spawning-grounds. It is seen, therefore, that while these fish at the commencement of winter seek shelter from the cold by burrowing deeply in the mud, at the approach of spring they revive synchronously with the maturing of the ova of the female and the milt of the male, and, having thus recovered their wonted activity (during February and March), no severity of the weather appears to deter them from seeking out exceptionally cold waters for their spawning-grounds. This was shown by the snow-storm referred to, after which the female minnows were still found passing up the brooks, forcing their way up miniature cascades with all the agility of salmon, leaping from eddy to eddy, seeking out the most distant points from their muddy summer haunts; and here, where but little water flowed, and with the long grass and twigs projecting from it thickly coated with crystal ice and glistening frost, I found the plainly colored mud-minnows lying half hidden among the pebbles and sandy ridges of the brook's bed.

Subsequent studies of this fish have resulted in noting certain peculiarities in its movements which may have some bearing upon the subject of evolution. On observing the movements of some remarkably large specimens in an aquarium, I was forcibly struck with the peculiar use they made of their pectoral fins. These fins in most fish are kept parallel, or nearly so, with the body, and they are usually thin, transparent, and with very flexible rays. These conditions, which vary in the thousands of species of fishes, do not obtain in the instance of the mud-minnows. The membrane is dense, the rays numerous and strong, and the fin is often held at a right angle with the body when the fish is in a horizontal position, and at more or less of an angle in whatever position may be assumed. The ventral fins, likewise stiff and strongly rayed, are not much used when the fish is swimming, but as soon as the fish comes to a rest they are spread out, and, with the pectoral fins now motionless and stiff, they form four "legs" that support the body, just as is the case with a salamander. Indeed, the likeness goes further, and the body is frequently curved when at rest, and remains so, the head being turned to the right or left, and the tail in the opposite direction. No one can fail to see the salamandrine appearance of this fish when it assumes such a position.

Now, if we follow up the habits of this fish, are there any other un-fish-like habits to be seen? Knowing its predilection for thick and muddy waters, its hibernating, and ability to withstand prolonged exposure to the atmosphere, as already described, indications of habits suggestive of a semi-aquatic life may reasonably be looked for. The one peculiarity, other than those mentioned, that I have noticed, is this: these fish, as I have mentioned, may often be seen resting on the tips of the pectoral and ventral fins. On disturbing them, occasionally, instead of swimming, especially if the water is very shallow, they make a forward movement, by giving these fins a leg-like motion, indicated by leaving faint traces, thus: ((((((((upon the sand. I first noticed this in observing specimens kept in a large aquarium, and since then have seen these same fin-marks made by the minnows in the mud in the bottoms of the meadow-ditches. It is often a voluntary movement on their part, I am now convinced, and not made only when disturbed. In fact, if suddenly disturbed, they generally dart off by swimming only, and bury themselves, tail-foremost, in the mud.

Taking now into consideration this habit, together with that of giving the body a salamandrine position, often maintained for several minutes, as well as that of burrowing in the mud, and also its capacity to withstand exposure to the atmosphere for a long time, is not the suggestion reasonable that a radical change may ultimately take place, and a semi-aquatic animal, allied at least in habits to the salamanders, be the result?

The mud-minnow is carnivorous. When kept in aquaria they will devour any reasonable number of flies offered them, and undertake, without hesitation, to swallow earth-worms, as large as themselves. Once they take hold of a worm, they never let go, but at least secure that portion of the animal between their jaws. Not only do they allow themselves to be fed, by taking food directly from one's hand, but they will leap above the water to seize any tempting morsel held above them. Learning this from observations of many specimens kept in aquaria, I was led to suppose that the same occurred habitually in their native haunts, and this is true. Unlike any other of our fishes, the mud-minnow will leap twice and thrice its length above the surface of the water to seize a fly or beetle that happens to rest upon some overhanging blade of grass or twig. So often, of recent years, have I seen this, while floating quietly along on the watch, that I am surprised that Professor Forbes, in speaking of the food of these fishes, should state that insects amount to but "fourteen per cent, chiefly undetermined larvæ," and further that "no terrestrial forms were recognized." While it is scarcely probable that a fish with so good an appetite could largely depend upon terrestrial insects for its food-supply, yet it is evident, both from aquaria studies and out-door observations, that these do constitute a considerable percentage of its food. With this species, as with many others which by their dentition show that they are carnivorous, it is probable that much of the vegetable matter found in their stomachs has not been taken voluntarily, but unavoidably; the fish swallowing portions of a plant often for the sake of the animal life that was clinging to it.

In the manual to which I so frequently have occasion to refer, I find no direct reference to a fish that is as much a fresh-water species as our shad or herring. Why it has been overlooked I can not understand, as I have seldom wandered about the river during the summer months without seeing numbers of this "exclusively marine" species. I refer to the silver gar or "bill-fish." Years ago I called attention to the great numbers of these fishes that are often caught in the canal, when the water is drawn off, in December, "at the close of navigation." Particularly during the month of August are these fishes plentiful in the river, and when sporting in company about a floating leaf or twig, darting over it and each other with a great variety of graceful movements, they present a most interesting sight.

They do not appear to leave the salt water at any particular time of the year, but "whenever the notion takes them" they wander up the river and thence into the tributary creeks. Once here, they seem in no hurry to return, as my note-books show them to have been seen in Crosswicks Creek in every month of the year.

As a fresh-water fish, the silver gar reminds me strongly of the pike. It preys upon the small minnows in the same manner; and at times it will remain motionless near the surface of the water, just beneath the spreading leaves of the splatter-docks. Unlike the pike, however, it is somewhat sociable and full of play. Often a half-dozen of them will chase each other with great animation, turning round and round in miniature circles. A curious feature of these gambols is the excessive curvature given to the body at such times. The fish will often describe a circle, with its body almost in a similar position. Then, quickly unbending, the circle will be again described, but reversed, the body being bent in the opposite direction.

It is not only the adult fish that come into the fresh waters of the river and the tributary creeks. I have often seen them, less than six inches in length, far up Crosswicks Creek, where the water was rapid, shallow, and very cold.

On questioning the more experienced fishermen, I find that a few of these silver gars are caught every year during the shad-season, but that only in August are they ever very abundant. Furthermore, this fact has been so frequently noted, that a local name, "harvest-pike," is in use in this neighborhood, based upon it.

De Kay does not appear to have known that this fish enters our rivers. At least, he refers to it only as a "coast" species. Nevertheless, the fish is frequently found in the Hudson, as far from the coast as Albany. De Kay further says, "It is highly prized by epicures." In this neighborhood, on the contrary, it is supposed to be poisonous. That it is not, I know to be true; but how far it is desirable as a food-fish I do not know from experience. They are too pretty to catch, and please me so much, as I watch them "at home," that I have no desire to drag them to my domicile to see how they taste.

Skipping the shad, for the world knows enough of it already, there are a few words to be said of another of the herring tribe that has become land-locked in this neighborhood. This fact has made them interesting; and it is well that they should find favor in some way. As an article of food they are absolutely valueless, or worse, for the bones are of such size, strength, and confused arrangement, that it is a foolhardy act to try to eat one of these fishes. I speak from experience.

Not very far from the house is a quiet, maple-shaded pond, where, summer long, the deep-voiced bull-frog sounds his doleful ditty, and the sprightlier swamp-frogs on the grassy shores, and bell-tongued Hylas on the drooping branches of the overhanging trees, wake the dull echoes with a livelier song. Here, out of the world, as it were, in green and sluggish waters that tempt no seeker for romantic scenes, there roams in listless mood this great, lazy, leaden-colored fish that denies, in its habits, any kinship to the great herring family to which it belongs.

In this pond, for nearly thirty years, these landlocked herring have lived and moved and had their being, subsisting on the myriads of small shells that they crush to atoms in their dense, muscular stomachs, the possession of which has given them their common name of the gizzard-shad.

This herring is common along our coast, and, entering the river early in the spring, wanders as far inland as do any of its tribe; but, unlike the others, it often gets into ponds which have an outlet to the river when the spring freshets occur, but which are shut off from the main stream when the waters sink to their ordinary level. In this way the gizzard-shad become landlocked, and under these circumstances they thrive admirably. Whether, in the pond to which I have referred, they come and go with every freshet, I can not tell, though I doubt it. Some, at least, that are in the pond have been there for several years; and many, for aught I know to the contrary, have been born and bred there.

These landlocked specimens are of interest as showing how readily an altered environment causes a decided alteration in color, and probably also in their anatomical structure. Comparison of these fish taken from the "maple-pond," many of which are descendants of the original fish that were landlocked in 1857, with those from the river, show them to be wholly different in color, and, more strangely still, their stomachs are certainly less muscular. I have examined a great many from this pond, supposed to have been hatched there, and at the time were from two to three years old, and there was certainly a smaller "gizzard" than in specimens of the same size taken from the river, and which had come but very recently from the sea. It is at least natural to speculate upon the probability of this herring in time losing the muscular stomach, as a consequence of not requiring such an organ for the digestion of the food that landlocked localities offer.

Other fish feed upon the same mollusks and have no such convenient gizzards, as, for instance, the perch and chub; but, then, the one has teeth in its jaws, and the other stout pharyngeal teeth that are admirably adapted to crushing. Do these take the place of the gizzard in the landlocked herring? If so, the need of it is apparent, and it will not wholly disappear, unless there is an entire change in the food. Still, there is a difference, in this respect, between these fish as found on the coast, and those that for several generations have been confined to small bodies of fresh water.

This landlocked herring is not always a sluggish fish, as I have seen it, in April, as full of life as is the most restless minnow. It seemed as though they had caught the full meaning of the warblers' merry notes, and were inspired by the sight of the crimson flashes of light that glance upon the water as the mad-cap oriole in his nuptial dress rushes hither and yon among the overarching trees. Indeed, at this time, the dull, leaden tints of this fish become a glistening blue, and bands of sparkling silver deck its ashy sides. No water seems too cold or too shallow for them. They dart like pickerel up the tiny spring-brooks that feed the pond, and skip and dance about the deeper water as though too joyful to contain themselves. From the muddy depths they rise to the surface, and, throwing themselves upon their sides, leap above the water, as though challenging the birds to match their brilliant colors. For a few days, their excess of action is kept up, and then it ends, as all such manœuvres ever do, in a profound reaction, when their humdrum existence returns; and so quietly do they keep themselves throughout the summer, that their existence would not be suspected by the casual observer.

CHAPTER XXXVI.

BRIEF NOTES ON FISHES.—(CONCLUDED.)

Considered as a group, there are no fishes so attractive to me as the "shiners." I do not like to separate them, and call one a chub, another a dace, and a third a minnow. This savors too much of later anatomical studies. My first attempt at field-notes reads thus: "Walked along the creek and saw lots of shiners"; and my latest rambles by the same stream can be no more comprehensively described. The "lots of shiners" still are there, and I only wish I dared sit under the old chestnut-trees, as I could once, and catch these same shiners with a pin-hook. Now, if I go a-fishing at all, it must be with "boughten" tackle and a basket, and only bass or pike must be angled for. This is called sport, but the fun of pin-hook and tow-string days is wanting. Now I can only gaze wistfully at these same shiners, and wish I was a boy.

This class of fishes, known scientifically as cyprinoids, are readily recognized as the roach, dace, chub, and minnow of our streams. There is a strong family likeness running through the class, and a general silvery coloring which has given rise to the comprehensive term "shiners."

I find that there are fourteen species in the creeks and river at this place. At least, following the text-books, this is true; but I have found others which are hard to determine, according to the descriptions given in the books; but as these lists are made up from a distorted, faded mass of alcoholic specimens, the probabilities are, that those who profess to know the most about these fish, still fall short of the whole truth.

Foremost among these cyprinoids, the shiner *par excellence* is the roach. It seldom happens that I look into any ditch, even, and fail to see a dozen or more of them lazily drifting about. They are eminently social, and are often found in enormous schools; but, unlike herds of cattle, droves of horses, or flocks of geese, the roach have no leaders. The danger that affrights one, influences all alike, and as one body away they dart, the moment a threatening shadow clouds the surface of the stream. To watch them, being yourself in full view, is a profitless undertaking. To follow them, yourself unseen, is full of amusement and instruction. At such times it may be possible to get an inner view, and so to determine in a vague way how much intelligence flits through their simple brains, although I must confess that the undertaking often is almost hopeless so far as the roach is concerned. Although watched for hours, they seemed as little like living creatures as the floating twigs that drifted with them. This was due, however, to two important facts: they were neither hungry, nor were they oppressed by enemies. Let either of these conditions be changed, and their manner changes at once. When food is discovered, it seems as if each individual roach of the school saw the coveted morsel at the same time, and a chase commences that is, at least, remarkable for the machine-like uniformity in time and motion with which they all rush forward to seize it. I have tested this frequently in this way: Going a short distance above the foremost of the school of roach, which always heads up-stream, and darts down when frightened, I would throw a grasshopper into the water. In an instant, the nearest roach would dart toward it, and usually seize it; but at the same time the hindmost roach would rush forward with equal promptness, although, of course, it could not have seen the grasshopper, and knew not why it darted forward, except for the reason that it felt the necessity of doing precisely as its neighbors. Then I would change my tactics, and throw a grasshopper into the middle of the school. In such a case, the nearest ahead of the insect would turn about, though they were seldom in time to catch it, and the fishes farthest ahead would likewise all turn about, apparently for no other reason than because those behind them did so. They could not have known the primary cause of the change of position of certain of their fellows, nor could there have been any hope of seizing the food, as that always fell to the fish nearest to whose mouth it dropped. Then, in a third manner, I would test the school by throwing a grasshopper some distance behind the last of the fishes. The struggles of the insect upon the surface would attract the hindmost roach in a moment, and the fish would reverse its position. Quite as promptly, the foremost fish would turn about in like manner. It was evident, therefrom, that these fish are so intimately associated as to act promptly as one body. What purpose does it serve? So far as a food-supply is concerned, it is disadvantageous, as the roach are carnivorous, and no such abundance of insect or other animal life is met with as to supply each member of a school of two or three hundred individuals. This social instinct would seem to have arisen as a means of protection. If so, I am "at sea" as to what enemies they elude by association. At present, the perch and pike prey upon them, and the former follows the schools until surfeited with both food and slaughter; the latter lies in wait and seizes the first to come within easy reach. In these cases, the social instinct works them no good. Can it be that each individual, knowing the danger to which it is exposed, seeks the company of others, feeling that thereby its own safety is increased? This is crediting them with intelligence beyond warrantable limits, perhaps, and assuming that they live their lives in a state of perpetual fear. Imperfect as is creation, it is hard to believe that any creatures are so unfortunately situated as this implies. Nevertheless, their actions, at times, are only explicable upon such an assumption.

The roach is an example of how far coloration may vary among fishes of the same species, and therefore how small reliance can be placed upon it in determining a "species." Years ago, De Kay described as not only distinct species, but as belonging to different genera, individuals of this cyprinoid received from different localities, and presenting marked variation of color and some minor differences of form. In rambling about this neighborhood I have found a great many roach in the most widely differing localities. I have found them in clear, cold, rapid waters, that would charm a trout, and in green-coated pools of such warm and thick waters that even frogs declined to enter them. In the former case, the fish were bright, silvery, and sleek, and darted to and fro, when disturbed, with all the animation of a trout; in the latter, they were of a dull, leaden hue, without a trace of metallic luster, and more sluggish and sleepy than tadpoles. Even the general increased vivacity of fishes in spring-time does not inspire these mud-haunting roach. They are thoroughly dull, listless, and lazy, and bear evidence of the direct influence of a depressing environment upon them. The only seemingly contradictory condition is the fact that clear, pleasant waters are within their reach, yet they do not see fit to leave their present unattractive quarters. In certain of the large, muddy pools frequented by roach, I have found some of the largest specimens of this fish that I have ever seen. It is seldom that in Watson's Creek we find one more than seven inches long, but, in a deep pool on a neighbor's meadow, roach measuring nine inches in length have been taken. These are very nearly the same in shape and color as those described by De Kay as the "variegated bream." Of this fish, that author remarks: "The name of *wind-fish* is derived from one of its habits. Whenever a light flaw of wind ruffles the water, thousands of these fish may be seen darting to the surface and as suddenly disappearing." This I have often noticed when, on approaching a pond suddenly, I have surprised a school of roach. The habit is not caused by wind ruffling the surface of the water, but is due to the fact that the fish were startled, and, indeed, it is common among all the cyprinoids. These fish generally keep just below the surface of the water, and so near it that any sudden movement is sure to ruffle it considerably. Without any apparent cause, hundreds of other shiners will leap an inch or more above the surface, and there is reason to believe that the cause of this is the sudden appearance of predatory fishes among them, just as the moss-bunkers, at sea, leap above the water by thousands when chased by the blue-fish.

Another well-marked variety of the roach, found in a small creek some distance from my home, are small, slender, and of a uniform steel-blue color. Even the fins differ from those of the typical roach in size, and, on comparison, other constant anatomical differences are to be seen. Some years ago I called attention to this fish as a variety that closely approached the boundary of a "species." Since then I have found these blue roach in Crosswicks Creek, and always in swiftly running, clear, cold water. It would seem, therefore, that the fish varies in a marked degree in accordance with its environment; and being a hardy species, capable of living almost anywhere, that variation is necessarily considerable. Considered from the evolutionary stand-point—the only rational one—it is an instance of the instability of species, so called, and shows how little change is necessary to bring about even permanent "specific" changes in the anatomy of a fish. Once let there occur a decided change of habits, and a change of structure will ultimately follow.

The next in importance among the cyprinoids, and one exceeding the roach in size, is the beautiful fall-fish, or rosy chub.

How great a change in habits may exist among the fishes of a family can be seen when comparing the habitat of this chub with that of a muddy-pool roach. No water is too clear, too cold, too rapid for the chub. They delight in stemming the swiftest currents of the river, and die at once if confined in quiet, sun-warmed waters. To find them in all their glory, I have but to go to the swift ripples about the rocks in the river. Here they congregate in large numbers in April and May, but wander about singly later in the season. Except during the spring months, they are not a social species, as is the roach. Chub are not confined to the river, however, for I find many of them wandering up Crosswicks Creek to the limit of tide-water. Here they delight in deep holes, and often I have caught specimens of the largest size by carefully sinking a grasshopper into some known deep hole in this creek.

Like all the cyprinoids, they are seen at their best during the breeding-season, and then, indeed, their coloring is gorgeous—blue, purple, crimson, gold, and silver—every tint brilliant, and all so blended as to produce a most pleasing effect. The fish either realize their attractive appearance at such times, or their unusual animation is a happy coincidence. At all events, every movement is in accord with their holiday attire, and no more interesting sight beneath the water is to be met with than the courtship of the rosy chubs.

Their courtship varies in nothing from that of the diurnal fishes generally. The males simply display their charms to the best advantage before the passive females, resist the encroachments of every rival, and in a few days have either chosen a mate, or been chosen—it is difficult to say which. It is probable that the females express their assent to the claims of such aspiring males as meet with their favor, and then off they go. Those who have carefully watched our fishes in spring see little difference between their methods of courtship and that of our birds.

In one respect, however, the chub differs materially from the birds and even many fish: it does not concern itself with the care of its offspring. Once the eggs are laid upon their bed of sand, all care as to their future vanishes. So, too, does the mutual regard of the newly mated pair. Leaving the spawning-ground, they are at once utterly indifferent to each other.

I find it to be a common impression among those fishermen who have given the subject any attention, that our "shiners," as a class, do not pair, but go in mixed schools to available spawning-grounds, where the ova are deposited and fertilized in the most careless manner, and that many of them are devoured by these same fish ; that many are destroyed by floating to unsuitable localities ; and that but a small proportion is really fertilized and sinks into the sand, and is left undisturbed while the growth of the embryo progresses.

While I am satisfied that this is true of many of our cyprinoids, if not the most of them, I am equally positive that it is not true of the rosy chub. These, certainly, are mated until the ova are deposited and fertilized, as I have mentioned.

There is yet another chub that I find in the same neighborhood, but the two are not associated in small streams. It has so happened that wherever I find the one, I never find the other. Why they will not associate I do not know; but when I have taken one each of these two species, and placed them in an aquarium, I have never seen any evidence of mutual dislike on their parts.

It has seemed to me that these comparatively dull-colored chub are less particular as to the localities they frequent, and can thrive fairly well in quiet and warm waters. I have never found them in still-water ponds, but so frequently in streams with but little current that the change to a pond would not be a violent one. Like the rosy chub, this plainer species, which is readily recognized by its smaller scales and black spot on the dorsal fin, grows to a large size, and is therefore of some value as food. Early in the year, particularly, the flesh is firm and well flavored, and I have often thought that it might be cultivated to advantage. Both species are carnivorous, but, as their food-supply is largely composed of insects and minute mollusca, the difficulty of feeding them, when placed in artificial ponds, would not be great.

There is but one brook within the limits of my rambles wherein occur the beautiful red-fins, and even here they are few and far between. In other brooks, four or five miles away, however, I find them in great abundance, and I often linger long by the babbling waters of the Shabbaconk, for no other reason than to watch the gambols of these cyprinoids, gorgeous in crimson and gold. Unlike most of this family of fishes, the male red-fins only present a brilliant coloring, and this they retain throughout the year. The difference during the breeding-season, from other times of the year, is in the greater prominence of the little tubercles that thickly dot their heads and upper jaw. These prickles are, in themselves, of no beauty, and rather mar the general appearance of the fish. Although prominent during the breeding-season, it is very questionable if their purpose is solely to render their possessors more attractive in the eyes of the females, as is evidently the case with bright coloring. When we know all about these prickles, their purpose will, in all probability, be found to have nothing to do with sexual attractiveness.

Red-fins are social the year through, and are seldom seen except in schools. Unlike the commoner roach, these fish separate in May, and for a while females will be found in certain portions of a brook and males in another. My attention was first called to this many years ago, when I noticed, in shallow, rippling waters, hundreds of male red-fins closely associated. The spot was fairly purpled with their ruddy sides and fins gleaming in the water. They filled a little basin in the brook, and showed no disposition to leave. Being disturbed, they passed but a short distance down the stream and resumed their closely associated positions. There were probably a hundred or more, and so close together did they keep that a space not over two feet in diameter contained them all. Not a female fish was among them. But they had been there, and deposited their ova, and the congregated male fish were then upon the spawning-ground fertilizing these deposits. Soon after, the sexes reassemble and lead a restless but scarcely eventful life. The young are left to shift for themselves, and to a certain extent are devoured by their parents. Professor Forbes * found but one specimen in twenty-one that had eaten fishes, but cannibalistic propensities are not so uncommon here among these fishes. Indeed, I find that all our shiners feed more or less upon very young fishes of the same or allied species. In speaking of the shiners, as a class, as carnivorous, I think we are essentially correct, and that vegetable food is taken only when animal food is not readily obtained, or because the two can not be dissociated. May it not be that the mud found in the intestines of cyprinoids was really teeming with life when swallowed, and this afforded the nourishment needed by the fish?

The various other minnows or shiners that I find, can most profitably be considered in groups, for it appears that the same localities attract various species of different genera. A sweep of the net will often bring up representatives of several natural groups; for these cyprinoids, while nearly the same in their habits, are very different in their anatomical structure. Occasionally, however, I have found a pool or a little stream teeming with individuals of but one or two species. Notably was this true when I first met with the typical pug-nosed minnows. These, so alike in general appearance, prove to be two distinct species, and belong to different genera. The great majority were those which, in the manual, are called silvery minnows—which all minnows are—and the others blunt-nosed shiners.

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* "Illinois State Laboratory of Natural History," Bulletin No. 6, p. 84. Normal, Illinois. 1883.

During the summer of 1873, with the assistance of an enthusiastic friend, I fished a spring-pond, some distance from home, and caught nearly one thousand specimens of the silvery minnows. From them I made the following notes with respect to their size and appearance: The adult size is probably five inches, and what is of much interest to the student is the fact that the intestinal canal is so very much longer than the fish. On careful measurement of over one hundred specimens, I found this length to vary to a certain extent, though it was never less than five and one fourth times the length of the fish. Unlike the other cyprinoids, the peritonæum in this species is uniformly and intensely black. The food of this shiner I supposed to be wholly vegetable matter; and this would seem to indicate that when the digestive tract exceeds the total length of the fish, the species is herbivorous, and when of the same length, or little exceeding it, that it is omnivorous, or carnivorous. This, however, I do not find to hold good. Recent examinations of the intestinal tract showed a very large percentage of animal matter, and not nearly so much mud as Professor Forbes reports in his examinations of Illinois specimens.

During the same summer I found a single specimen of the blunt-nosed minnow. It was associated with the preceding. The external differences were readily seen, but, to make matters the more sure, I dissected it, and the short digestive tract and silvery peritonæum at once showed that it was a wholly different species.

Since then I have frequently found them in numbers in the canal and in still water in the river. Many often collect in the eddies about the larger projecting rocks, and fall a prey to the hungry schools of perch and rock-fish. My attention was first called to the abundance of these minnows in the river by finding remains of several in the stomach of a rock-fish.

Neither of these minnows find their way into the ditches in the meadows or into Watson's Creek, though they often come up into Crosswicks Creek directly from the river. They are never, however, so abundant here as in the river above tide-water. Cool, clear, constantly running water seems to be their natural home.

There is yet another group of shiners, which is represented in the streams near by, by four species. The species of this group vary wonderfully in size, as one of our largest shiners—the spawn-eater—and the very smallest are included in it. This group has no common name by which they are known. The term "minnow" or "minnie" is that invariably applied to the smaller representatives; "shiner" to the larger species.

The largest of the four species in this natural group, and one that is very common in the river, is the so-called "spawn-eater." De Kay says of this species, "It is called 'spawn-eater' from an idea entertained by fishermen that it lives exclusively on the spawn of other fishes." If this were true, it would be forced to fast about ten months of each year, which would not suit fishes in this neighborhood, for probably no animal consumes a greater bulk of food in the course of a year than a fish.

The belief that these minnows are spawn-eaters has no doubt arisen from the fact that the fish has a sucker-like habit of feeling carefully over the bottom of the stream with its peculiar "telescopic" mouth extended, and so sucking up such food as it finds to its liking. The examination of the stomachs of many specimens, at different times of the year, shows that, like the common roach, it feeds very largely on small crustacea and the minute mollusca adhering to stones and other stationary objects in the beds of our streams. I am quite sure that the charge of spawn-eating can not be laid to this fish with more reason than to all other cyprinoids. Indeed, without an exception, the ova of all other fishes are to every species of fish a luscious morsel; and I have seen sufficient evidence to convince me that not only this species, but all cyprinoids, are "spawn-eaters" to a certain extent; but that the name is more deserved by any one species over another, I strongly doubt.

Another shiner of this group, which has been favored with no distinctive name, is very abundant in the rapid water of the river, but appears never to seek the quiet inland streams. The principal external difference characterizing this shiner, when compared with the preceding, is the more tapering snout and the more slender and graceful outline of the whole body.

Some years ago, I found many of them in very swift waters, at the mouth of the Assunpink Creek. They seemed to be determined to go up the falls, and never tired of making efforts to ascend, although, of course, they made no progress. I captured a few and sent them to an ichthyologist in Philadelphia, who pronounced them a "new species," and gave them a Greek name; but in the manual they are said not to be "new," but old. To me they are minnows of good size, great activity, and beautiful color, and so they add a charm to the waters they inhabit, and what more need one care to know?

So much for the larger shiners of this group; but what of the smaller ones? These also must be considered collectively, for I never found the one species without as many individuals of the other, and never saw a solitary individual of either. Then, too, wherever these little minnows are found, there are sure to be a host of similar-looking fish, but which, in consequence of some extra wrinkle in their skins, are called by another and longer scientific name. This need not concern us, however, as they are all little minnows, the most diminutive of the whole family of cyprinoids.

In every little water-way throughout the meadows, as well as in the two creeks and the river, these three little species of minnows are at all times extremely abundant. They are the first to appear in open water when the ice is disappearing, and they are the last to leave their summer haunts when the ice binds every ditch and brook in crystal fetters. Perhaps it is nearer the truth to say that they are "on the go" the year through, as I have recorded them as abundant at various times during the three winter months.

While the social habits of these three small fishes —none ever measuring two inches in length—clearly indicate that they possess some rudiments of intelligence, it is not easy to determine in what way they enjoy existence, if the term "enjoyment" is applicable to them. I have watched schools of them for hours, and find that their sole efforts are directed toward escaping dangers. The three species, collectively, have more enemies than any other creatures in the same neighborhood. No mammal, bird, reptile, or amphibian, nor any species of fish, is beset with half so many enemies. There is not a predatory fish in the same waters that does not largely depend upon them for food; the young of larger cyprinoids being, of course, available yearly but for a brief period. Even the frogs seize them as eagerly as they do struggling grasshoppers or chance insects; the snakes and turtles chase them eagerly, or take them by surprise, as opportunity offers. If a receding tide leaves them in shallow waters, birds of a dozen species eagerly hunt them, and late in the spring, when after the freshets chance pools become nearly or quite dry, mice and squirrels will feast upon the decaying bodies of these little minnows, that may have escaped the searching glances of our many birds. Even spiders have been known to capture single specimens and lift them from the water. Their principal safety appears to lie in taking refuge in weeds, where they are not seen so readily. I found that this was their principal method of avoiding the single predatory fish I kept in the same tank with them. They are not disposed to remain hidden, however; and soon after rushing pell-mell into a mass of weeds, they reappear and face the dangers that they know confront them. Where they feed and what they feed upon I can not say, but their movements at times clearly indicate that they find something to prey upon, but the objects are so small that I could not detect them with the naked eye. This I have tried by scooping up a bucket of water where the minnows were feeding, but such efforts availed nothing. I am satisfied that, small as they are, these little minnows are carnivorous, and suggest that they have the power of seeing such forms of animal life as can only be detected by man with the aid of a microscope.

When these little minnows enter the more shallow waters, in March and April, it will be noticed that the coloring of about one half their numbers is more brilliant than during summer and autumn. The fins are even rosy, and the lower lines of scales almost crimson. Early in May this color begins to fade, and is soon replaced by the characteristic silvery hue of the remaining months of the year. This growth, climax, and fading of gorgeous colors, which is confined to the male fishes, correspond with the growth of the eggs in the females, and their deposition. Just when this takes place I have not been able to determine, nor whether it is preceded by the building of a nest of pebbles, as we shall see is the case with the equally common black-nosed dace, to which reference will be made on a subsequent page.

Passing through the meadows, over to Crosswicks Creek, I often linger by one of the large springs issuing from the hill-side, for the purpose of watching the score or more of "silver-fins" that are always there. Although these fishes are of a dull, silvery hue only, they are, nevertheless, exceedingly beautiful. They have an indescribable grace, and are very conspicuous from the satin-white coloring of their fins. Found only in clear, rapidly-running waters, they are in all respects fit occupants of such localities, and do not give the impression of being intruders, as do the occasional roach or cat-fish that happen to wander into the same spring-brooks. A silver-fin is as much at home in the spring-brooks as the trout itself.

The habits of this cyprinoid are essentially the same as those of the red-fin, already described. They spawn in May, depositing 'the ova in little basins of clean sand in the bed of the stream, and there the eggs are left, without a trace of subsequent attention from the parent fishes. I believe the young fish are two years old before they acquire the satin-white coloring of the fins which makes them the most conspicuous of all our cyprinoids, except the red-fins.

In less attractive places, but where the water has a decided current and is moderately clear, as in the canal and the river, there is another scarcely less attractive minnow, which the author of the manual quite ignores. This is the rosy minnow, that I first found, nearly ten years ago, in the canal near here. In general appearance it is more like the rosy minnow described years ago by Professor Agassiz, than any other cyprinoid, though it is quite different.

The first specimens that I found were collected late in August, and the colors noted while they were in an aquarium. The back is olive-green, the sides bright silvery; the scales generally marked with minute black dots. As in the preceding, it is not the coloring but the general appearance and grace of movement that make this species so attractive and beautiful.

The name of rosy minnow is only applicable to the male fish in spring, when the silvery sides become a beautiful shade of red. This lasts, however, but for a few weeks.

Since 1873, when I first found these minnows, I have collected many others, and always in the canal or river. They do not appear to enter Crosswicks Creek at all, though why they should prefer the canal to the creek and the net-work of ditches, is a problem I will not attempt to solve.

Associated with the above, in several instances, as I find recorded in my notes, were individuals of a curious cyprinoid, the "rosy dace" of the manual, and "pike-shiner" of my memoranda. These cyprinoids are of great interest because they have a fierce, pike-like appearance, and their habits are in accordance with their appearance. In other words, they are very suggestive of evolution, and are, in fact, an apparent branching off from the original stock.

To see these "pike-shiners," as the boys about here call them, singly, moving deliberately about, at once recalls the pike; and while I have never seen them catch a fish and devour it, they do snap and swallow insects in the most approved trout-like manner. Other cyprinoids do the same, I know, but none have the pike-like quickness, and I may add ferocity, of this species. This I thoroughly tested by keeping several of them in my aquarium. They quickly caused to disappear a score of the small minnows in the tank; although I never could see them in the act of molesting these smaller fishes.

They are not abundant, and I am not sure but that I should have overlooked them had I not heard them spoken of by juvenile anglers, who asked me if the fish in question were "real shiners or some sort of a pike." These boys had become familiar with a species of fish in this neighborhood that had, up to that time, wholly escaped me. I have been less positive as to the extent and accuracy of my knowledge of our fishes ever since.

The true dace, of which I find two species, are very different in every respect from the preceding. One of them, the black-nosed dace, is an exceedingly common species, and is found in every brook and ditch that has anything of a current. Like the red-fins and silver-fins, these dace must always be struggling up stream, and darting, when frightened, down stream; but in quiet water they are at once lost, and, after moving restlessly about in a vain endeavor to find a current, they give up the effort and the ghost together.

Mr. C. F. Holder, from whom I have already quoted in regard to other fishes, remarks of the black-nosed dace: "In the warm weeks of June come the sterner duties, the nesting-time; male and female join in the preparation, and the locality is selected, perhaps in some running brook, in shallow water. Roots, snags, and leaves are carried away, both sometimes tugging at a single piece, taking it down stream, and working faithfully, until we, who are watching from the bank, despite the strong protest of the ants, see a clearing over two feet in diameter. Here the first eggs are deposited, and the male, who has retired, soon appears from up-stream, bearing in its mouth a pebble, that is placed among the eggs that form a layer in the center of the clearing. Now they both swim away, soon returning, each bearing a pebble in its mouth that is dropped upon the eggs. Slowly the work goes on, until a layer of clean pebbles apparently covers the eggs; now the female deposits a second layer of eggs, and more pebbles are brought, the little workers scouring the neighborhood for them, piling up stones and eggs alternately until the heap attains a height of eight inches or more, formed in various shapes, sometimes pyramidal or dome-shaped—monuments of the patience of these finny house-keepers. Who would suspect their purpose? Even the gleaners of the golden fields, in whose brooks our little friends are found, have not discovered their secret, and think the curious piles washings of the brook itself."

The other dace, the long-nosed species, is still more dependent upon clear running water, and dies immediately if placed in still waters, as in an aquarium. Even water kept cold with ice does not suit them. It must be both cool and rapidly flowing.

There is but one brook within the range of my rambles where the long-nosed dace is found, and here they occur but sparingly. I have usually found them beneath flat stones, or hidden by the overhanging banks of the brook. The moment they are surprised, away they dart, and seek shelter in some such place as I have mentioned. For this reason they are difficult to capture, and being but seldom seen, unless carefully looked for, they are readily overlooked by the casual observer.

The sixteen species of fishes that have been so briefly referred to in the preceding pages are worthy of much study, but collectively, rather than with a view of determining just in what particulars they differ among themselves. As a group, they are of much importance in the economy of nature, as must necessarily be the case where any animal exists in vast numbers in comparatively crowded quarters.

During the past few summers I have studied these fishes as a group, in the hope of discovering the influence they exerted upon the general fauna of the locality, and have reached the conclusion that the part that cyprinoids play is mainly that of a check upon the undue increase of lower forms of aquatic animal life. In consequence of their vast numbers, they prevent the fouling of much water that would otherwise become offensive, and yet do not, of themselves, contaminate the water, however numerous they may be.

Cyprinoids, as a class, are carnivorous, or more properly omnivorous; and although with weak, toothless jaws, the arming of their pharyngeal bones with powerful cutting and crushing teeth enables them to feed upon animal substances as readily as do the predatory species of fish. I judge that the great bulk of their food is the minute animal life that teems in all water, and also the small mollusca, of which they devour enormous quantities. The result of my studies of such of these fishes as I have kept in aquaria is, that young mollusca are the favorite food of cyprinoids, for I found it very difficult to so plentifully supply them as to surfeit the fish to which they were offered. It is in this way, I believe, that the cyprinoids aid materially in keeping our streams in that condition which we call "pure."

From an evolution stand-point, these fishes are exceedingly interesting, and, I may add, instructive. By a "species" let me here state that nothing is meant but a convenient arrangement of the various forms of animal life for purposes of study; and in the "species" of cyprinoids is seen only so many varied forms evolved by natural selection from some primitive form of omnivorous fresh-water fish, from which has sprung a variety of forms, through a countless series of generations, that have, each in its own place and time, become suited to the particular haunts they chanced to frequent or were forced to occupy. Considering a "species" in this way, and also bearing in mind the amount of variation seen among any considerable number of individuals of any one species, and knowing that varieties are steadily becoming more and more differentiated and are thus entering what may be termed "specific territory," I claim that it is not an unwarranted use of the imagination to picture to one's self a primitive, typical cyprinoid, from which the sixteen so-called "species" in this neighborhood have been derived.

The Delaware River and its several tributaries in this neighborhood are well supplied with that family of fishes popularly known as "suckers"; fish that are most nearly allied to the cyprinoids proper, about which we have just been speaking. I have always been puzzled to find the merits of these great lubberly fish. The last consideration in my mind, in studying animals, is their value as food for man; though even in this regard very little can be said in favor of these abundant, but utterly stale, flat, and unprofitable fish.

Inasmuch as these same suckers, or catostomoids, are among the earliest of the river fishes to come up stream in the spring, they should have a kindly word spoken of them. Unfortunately, they come in such a stupid, listless manner, that no enthusiasm is roused in watching them, as there is when the first flock of blackbirds darkens the sky in March. When I see the suckers in March moving slowly up the creeks, I always think of the

> "ten thousand men
> That marched up hill and then marched down again."

There does not appear to be any animation about them; no points of interest that stay our footsteps for a moment. As an urchin of five summers once remarked to me, "Does they knows what they's come for?" It is an open question whether they do or not. I have found what I take to be their bones in Indian shell-heaps on Crosswicks Creek, and my only wonder is that the Indians should have thought them fit to eat.

The manual, at hand, to which I refer for the most recent nomenclature of the "species" found in these waters, allows us five varieties of "suckers."

Of these there are two, known locally as "river suckers," which throng the river and creeks in March and then very generally disappear, or, in other words, return whence they came, to the deep waters of the lower, tidewater portion of the river. A third species, which my neighbors call the "chub-sucker," is also found in the river, but, unlike the others, is equally abundant the year through. It is particularly obnoxious to those who are fond of line-fishing, as it is believed to be, of all spawn-eaters, the most persistent and destructive. I have endeavored to trace out the origin of this common impression, but without success. That it is true of it I doubt. A still less abundant species of this group is that known locally as the "mud-sucker." This local name is said by the author of the manual to be inappropriate, and that the fish frequents clear streams and rapids, and is not at all a "mud-fish," as some writers seem to suppose. Now it is very probably true that this fish is a "stone-roller" out West, but this does not prevent its poking into the mud in the Delaware Valley. Some years ago I found a number of these fish in Crosswicks Creek, and noticed their decided preference for the muddy bottom and comparatively still waters of certain portions of the creek; and in all the years since then, there has been nothing noticed in their choice of locality that has led me to think otherwise. In this same creek there is an abundance of rapid waters and pebbly bottoms, but these are not frequented more than the mud. Since the publication of the manual, I have looked this up, and know whereof I speak. For instance, one pleasant August afternoon in 1881, I slowly floated with the tide down the creek, and carefully watched a number of these black suckers as they were slowly swimming up the creek. They were all moving in the same manner, with their noses thrust a short distance into the mud, and they left behind them, as they passed by, a shallow, wavy line in the mud, which was easily traced through the clear waters. Had I seen no fish, I should have taken these lines to have been the tracks of mollusks.

Lastly, there is the omnipresent "mullet," and verily I do not think there is a rod of shallow ditch, even, that is not tenanted by a dozen of them. When young, they associate with whatever cyprinoids happen to be wandering in the same waters, their habits being essentially the same. Unlike the other four "suckers" I have mentioned, this fish, when young, thrives well in perfectly quiet water, and seems to suffer no inconvenience when the July sun warms the still ponds to such a degree that all the other fishes leave in disgust, and seek the bubbling springs, or bury themselves in the mud. This latter is a trick of many fishes that are not supposed to have any liking for either mud or "thick" water.

Adult mullet differ from the young of one or two summers in being strictly nocturnal. Throughout the day they remain quietly at rest among the weeds in the bottom of the creek or ditch, but on the approach of darkness they are full of activity, and not only wander to and fro through the water, but come to the surface and even leap above it. The change is very great. It is during this excited state, or throughout the night, that these fish utter audible sounds which will be referred to in a subsequent page.

There are two well defined species of cat-fish common to the river and creeks about here, and it often happens that an apparent third species is found; but this I am inclined to consider is merely a hybrid.

Of these, the first is the common white cat-fish. This is exceedingly abundant in the river and in all running waters. Such localities it prefers—indeed, are essential to it—and once out of them, it promptly suffers much discomfort. It is due to this fact, I suppose, that it is far less tenacious of life than the other species.

In the river, the white cat-fish, which by the way is often glossy black, and sometimes mottled, is usually found associated with the schools of white perch, when the latter are coming up the river. The cat-fish, however, do not migrate, as do the perch. So far as I have been able to learn by questioning old fishermen, there is no one time of the year when they are more abundant than at others.

These fish, it would seem, have been utilized by some who would fain foretell the character of the coming winters. I have endeavored to trace the origin of many of these "sayings," as already mentioned when speaking of the squirrels and musk-rats, and I also tried to determine how much truth might be contained in any of these so-called signs. In not one of them has anything worthy of credence been found. Here is a "weather sign" referring to cat-fish, which I have clipped from a newspaper. It is evidently as meaningless as are all such so-called signs:

"How do you tell when it's going to be a cold winter, Uncle Abe?"

"I mostly tells by de fish. I been a fisher all my life, ever since I been a little nigger so high, and if you notice a cat-fish in de fall you will see dat sometimes de skin on his belly is thick and sometimes it is thin. When its thick dar's gwine to be a cold winter, an' when it's thin dar's gwine to be a warm 'un. I never knowed dat sign to fail."

"How is their skin this winter, Uncle Abe?"

"I'm mighty sorry to say, chile, it's mighty thick."

The other and even more abundant cat-fish is the "mud-cat," or, as my young friends invariably call it, the "catty." This is essentially a meadow and Watson's Creek species with us, and it is almost as abundant, even in the ditches, as the mullet.

However enthusiastic one may be, I can scarcely conceive of any one becoming excited over a sleepy cat-fish, as it lazily loafs over stretches of mud, and threads its languid way through a forest of lily-stems. This, in fact, about covers the range of its habits for fully ten months of the year, as I have no reason to believe that cat-fish hibernate; at least, about here.

During the months of May and June there is a change for the better, and it is interesting to observe the care then exhibited by the parent fish in guarding their numerous progeny. Unlike the majority of our fishes, who know nothing of their young, the cat-fish guard theirs with much solicitude, and often brave great dangers to extricate such of their young as may have fallen into trouble. In thus caring for their offspring, they remind one forcibly of a hen and her chickens. The old fish scratches the mud, or rather roots it up, with as much earnestness as a hen does the dunghill; and the young fish crowd about her head, as eager for something edible as are the chicks for worms or seeds. The similarity may extend further, and the old fish may cluck to her young; but of this I am not positive, though I am inclined to believe it. That cat-fish have a fairly well developed voice is unquestionable.

In order to test the patience and affection for their young, possessed by this fish, I experimented in this manner: With a scoop-net I captured nearly an entire brood, and put them into a large glass globe, which I covered at the top with fine sieving. Placing the globe with its contents in the water, I was delighted to find that the parent fish evidently recognized its offspring, and was, as can well be imagined, in great trouble and perplexity at their evident imprisonment, which was a great mystery. The parent fish swam boldly up to the glass, and was brought to a stand-still by the unseen barrier which separated her from her young. So long as I watched, the bewildered fish did not cease her efforts to break through the mysterious something that prevented her young from escaping. I left the globe in the water through the night, and found early the next morning that the faithful parent was still at her post. As the confinement was proving fatal to some of the young fish, I released them. The parent remained as near as she dared, and as the young clustered about her she seemed to give each a kindly greeting and no doubt a word of advice, for no sooner was the globe emptied than the whole brood surrounded their parent, and quickly swam away in very compact ranks.

To this day, if fishes talk, the curious adventures of that brood of cat-fish are surely related by the descendants of those who were concerned in them.

I subsequently repeated this experiment with certain variations, and with even more satisfactory results. I placed the glass globe containing the brood of young cat-fish on the bank of the stream from which they were taken, and in full view of the parent fish, which was greatly excited by being deprived of her charge. This fish at once recognized that her young were not in the creek although they were swimming in water. After a variety of restless movements, its curiosity overcame its discretion; and it left the creek, and, as best it could, made its way to the base of the globe containing her young, a distance of about two feet. Here she remained for nine minutes, quietly watching her brood, and then returned to the water. In a few moments she returned, having recovered from the effects of exposure to the air. I now liberated the young cat-fish; and they immediately clustered about their parent and followed her into deep water.

Wherever you find cat-fish it is quite certain that eels also abound in equal or greater numbers. In most of their habits the two species of fish are quite alike, when in the same ditch or pond; but the eel has this advantage over the cat-fish, that it can leave the water when it chooses and wander away to some new locality. To what extent this power to live in the atmosphere for a long time, and progress, snake-like, for long distances through wet grass, explains their presence in small spring-ponds without surface outlets, I do not know, but that it bears directly upon this question can not be doubted.

In the spring of 1879, while watching the progress of the work of grubbing and otherwise clearing a piece of swamp-meadow, I was surprised to find a group of eels, seventeen in number, in a mossy mass of earth and roots of loose texture, through which water from a spring near by freely circulated, but not in such quantities as to enable a fish to swim. These eels were not a tangled mass, so interwrapped as to suggest the idea that they sought contact with each other for mutual aid or warmth, but each was twisted, rather than coiled, in quite a snake-like manner by itself, and while each was very near its neighbors, probably no two were in contact. On taking them up—they varied from six inches to a foot in length—they seemed somewhat sluggish and indisposed to escape until revived, as it appeared, by the warmth of the hand, when they struggled to be free; and several escaped, as they were covered, as I subsequently found, by an unusually thick coat of slime. Their movements over the damp earth were quite unembarrassed, and I noticed that while there was nothing to indicate the proximity of running water, these escaping eels wriggled in a very direct line for the nearest point at which they could reach the ditch. I permitted them all to escape but two, which I dissected. There was so small an amount of matter in their stomachs and intestines, that they must have been fasting during their semi-aquatic sojourn in the spot where I found them.

Close examination showed that the spring-water did not and had not run as a stream from or through this spot; and though it was submerged during unusually high water, yet it was not possible that those eels had reached here during a freshet, and had remained here ever since, especially as it was more than a year since the place had been under water. There was every indication that these eels had voluntarily left the ditch, some fifty feet distant, and sought out this spring-hole, which, owing to its southern exposure and constant supply of water, was certainly a comfortable spot. But the question arises, Is this a common occurrence? Furthermore, do eels habitually hibernate, choosing ordinarily the soft, muddy bottoms of our deeper ponds, and the tidal portions of our rivers? I know they are generally supposed to do so, but the frequency with which I have taken them when fishing in deep waters under the ice, has led me to doubt whether the habit is as common as is supposed.

It is fitting that my notes on our common fishes should terminate with the rarest of them all, the gar, which of late years is but rarely seen in the Delaware or its tributaries. Not only are they seldom seen now, but I find no reference to them in the writings of such early travelers as took an interest in the fauna of the country.

The gar should not be confounded with the bill-fish, which is also called "gar" by many of our fishermen.

The true gar is found in the river all the year round, and occasionally a big fellow wanders into Crosswicks Creek, near by, and here I have occasionally been fortunate enough to see them.

As to their habits, so far as I am concerned, there is not much to be said. They are much like the pike, remain much of the time half concealed in the river-weeds, and when a small fish comes near, dart at and seize it with all the agility of that fish. Sometimes they seize a large chub midway across the body, and worry it nearly into halves by a slight motion of the jaws. When satisfied that the chub can not escape, they loosen their hold, and, taking it in a more convenient manner, they swallow it without further preliminary carving. Zadoc Thompson, in his "History of Vermont," refers to the feeding habits of the gar as follows: "This singular fish was described by Samuel Champlain as an inhabitant of the lake now bearing his name, more than two hundred years ago. He called it *Chausarou*, which was probably the Indian name. The Indians assured him they were often seen eight or ten feet long, but the largest he saw was only five feet long, and about the thickness of a man's thigh. It is considered a very voracious fish, and when any of them are taken or seen in the water, the fishermen calculate upon little success in taking other kinds. Charlevoix tells us that he preys not only upon other fishes, but upon birds also; and that he takes them by the following stratagem: concealing himself among the reeds growing on the marshy borders of the lake, he thrusts his bill out of the water in an upright position. The bird, wanting rest, takes this for a broken limb or dry reed, and perches upon it. The fish then opens his mouth and makes such a sudden spring that the bird seldom escapes him. Charlevoix also assures us that the Indians regarded the teeth of this fish as a sovereign remedy for the headache, and that pricking with it where the pain was sharpest took it away instantly." I must confess I have my doubts about this stratagem on the part of the gar, but if it was true of them in Charlevoix's time, is it at all probable that they have lost the art since? On the other hand, if gars were so smart then, were other fishes equally cunning, and have they all become less knowing in their ways?

There seems to be an impression that the gar is a fresh-water fish exclusively, but this is a grave error. I have learned from observing fishermen that many more are caught in the brackish waters of Delaware Bay than higher up the river. Whether they ever pass out to sea I do not know, but certainly they often go to the very dividing line between the bay and the ocean proper.

My last opportunity of seeing a living gar was late in the summer of 1880. My attention was attracted to it by its coming to the surface and discharging a great mass of air, which formed bubbles on the water. Then the fish floated for several minutes, lying so near the surface that a small portion of his entire length appeared to be out of water. Suddenly he rolled over and disappeared. An hour later, I saw what I suppose was the same fish, go through the same motions, about one hundred yards from the spot where I first saw him. The habit of coming to the surface to discharge air seems to be common to them, but in the few instances that I have seen there was no sound made at the same time, so far as I could determine.

CHAPTER XXXVII.

TRACES OF VOICES IN FISHES.

In Peschel's volume on "The Races of Man," I find the following paragraph, and it seems a fitting text wherewith to preface a few remarks on the subject of indications of voice in some of our fishes. He says: "If speech be but the means of communicating emotions or intentions to other beings, even invertebrate animals possess faculties of the same nature. We see insects, such as ants, which live in so-called communities, carrying out elaborately preconcerted warlike undertakings and attacks. A beetle, which in rolling the ball of dung inclosing its egg has allowed it to slip into a hole from which it is unable to extricate it, flies away, to return in a short time with a number of assistants sufficient to push the ball up the sides of the declivity by co-operation of labor. These creatures must, therefore, unquestionably possess some means of communicating with each other concerning this combination. It requires no long observation of our song-birds to distinguish the different tones by which they warn their young of danger, or call them to feed, or by which they attract each other to pair. These animals, therefore, have at their control a certain number of signals which are quite adequate to procure for them some few of the wants of their life, and these signals, as far as we can at present guess, have been acquired and inherited in the same manner as were their instincts."

Although we are all familiar with the lazy drum-fish of our coast—and some may have heard those grunting sounds that have given this species its common name—the little fishes of our inland brooks and the more pretentious denizens of our rivers are looked upon as voiceless creatures, so that if they have ideas, they must express them by movements entirely, not of one portion, but of the whole body. In fact, however, the conditions that obtain among insects and birds, as mentioned in the quotation from Dr. Peschel, are, in a measure, applicable to some of our fishes; at least, in my studies of the habits of our more common species, I have been led to believe that certain sounds made by these fishes are really vocal efforts, and that their utterance is for the purpose of expressing an idea; and, furthermore, I am of the opinion that these sounds are closely connected with their breeding habits, although I have heard them at other seasons.

Probably no one has failed to notice the brilliant colors of the restless red-fin, as it darts to and fro through the clear waters of a crystal brook, or the bright orange-tinted fins of the silvery roach, that ere summer has passed pale to dull yellow and lose all their glow; but while with all our fishes there is at one time of the year a deepening of every tint, this is in no wise comparable to the gorgeous hues Nature has vouchsafed to a certain few. My studies of the habits of these common fishes have led me to think that the bright colors of spring-time, which are analogous to the breeding plumage of male birds, might possibly bear the same relationship to vocal sounds that the songs and plumage of birds do to each other. With but few exceptions, our finest songsters are dull-colored birds. Have our plainer-tinted fishes a compensation for this attraction of color in the ability to utter sounds?

After several summers spent in observing the breeding habits of these common fishes, I have ventured to form two tables, relating to the breeding habits and their connection with the color and supposed voice of sixteen species of fresh-water fishes. In the first of these, I have simply separated them into bright and dull-colored species; the bright coloration referring to the breeding dress or spring tinting. In the second list, I have separated them according to their supposed vocal powers; and it will be seen on comparison that a combination of voice and conspicuous coloring does not occur.

TABLE I.

Brilliant Colors.	*Dull or Silvery.*
Yellow perch.	Pirate.
Common sunfish.	Mud sunfish.
River sunfish.	Gizzard shad.
Red-fin.	Mullet.
	Eel.
	Cat-fish.
	Lamprey.
	Sturgeon.

TABLE II.

Supposed Vocal Power.	*Voiceless.*
Pirate.	Yellow perch.
Mud sunfish.	Common sunfish.
Gizzard shad.	River sunfish.
Mullet.	Banded sunfish.
Lamprey.	Chub.
Cat-fish.	Roach.
Eel.	Red-fin.
Sturgeon.	Pike.
	Bill-fish.

We have here enumerated four species that are brilliantly colored, and eight that are dull or simply silvery; and of the former, none are believed to have any voice proper, while of the eight of the right hand, all are believed to be so endowed. In the right-hand column of Table II, it will be noticed that among the "voiceless" species are included the four highly-colored fishes and five others, all of silvery tints, which I have carefully studied, and which have no habit, so far as I could discover, that would separate them from the species that are without a voice. We can then scarcely avoid the conclusion, that with fishes as with birds the brilliantly-colored males, as a rule, are mostly if not wholly dependent on their hues to attract the females during the amatory season.

Those who may be familiar with the common chub will doubtless urge, as an exception, that the peculiar grunting sounds made by it when taken from the water entitle it to a place among the fishes that are supposed to have a voice. Cope, in his "Cyprinidæ of Pennsylvania," says, "When taken from the water, it (the chub) utters a chirruping and croaking noise, more like a voice than any sound heard from any other fresh-water fish of our region." I have not, however, been able to detect this sound except when removed from the water, and as the fish is then out of its proper element and struggling, it may be involuntary. The deep-bronze and golden-green tints of the mud sunfish, too, might be urged as a case of high coloration and a sexual attraction, and so it should be voiceless; but this fish, of all those observed by me, has been the one most frequently to utter sounds voluntarily when confined in an aquarium. I doubt not there are very many exceptions, and one great objection to the suggestions I have made is that there probably is too great an array of opposing facts. But to refer once more to the case of birds. Assuming the correctness of evolution, as I do, then we need go back but a very short period in geological time to see the numerous species of our birds reduced to single representatives of each genus, and even far fewer of so-called genera. With the avifauna thus simplified, the differences that now exist between our somber-hued songsters and the gayly-colored songless birds were more distinctly drawn; and this may have been true also of our fishes. The vast influence brought to bear upon all animals by their surroundings, and the increasing struggle for existence, has evolved in later times, and ever is evolving, innumerable variations in the forms of life; and these changes have in so great a measure obscured the conditions that once characterized both our birds and fishes, in the matter of the relationship of voice and color, that what I believe to have been once a well-marked feature of animal life is now traced with difficulty. Nevertheless, the many instances of apparent voice that I have noticed, and their relationship to color, induce me to believe that what is now scarcely a rule, perhaps, among fishes, was once a law that governed them.

In studying these same fishes in another phase of their habits, we see that, while all the species enumerated are more or less active throughout the day, some of them are far more so at night, and shun, if undisturbed, the glare of the midday sunshine. These partially if not strictly nocturnal species are those that I have considered as having the power to give out or utter a truly vocal sound, and they are the more plainly colored species. The brilliant tints being of little or no use by night, necessitates the diurnal habits of those fishes possessing them, while the nocturnal species, with a voice as a compensation for the lack of color, are enabled to carry on a courtship in part by its aid, which would be of little or no use during the day.

Having given an outline of the conclusions reached on the supposed relationship of voice and color among certain of our common fresh-water fishes, let us consider in detail the characteristic habits of two of the best known and most widely differing species of the lists. As representing the voiceless but gayly-colored fishes, let us take the common sunfish, and, on the other hand, the equally familiar cat-fish as an instance of a fish that has the power of uttering a sound—that has the rudiments of a voice.

With the bursting of the leaf-buds and disappearance of the ice from the shady nooks of our quiet inland ponds, the gayly-tinted sunfish, which all winter long has been lazily loafing in the deeper waters, polishes up his old coat until it looks as well as new, and, coming boldly to the sunny shallows, he darts restlessly about, an object of admiration to himself, and, what is of more importance, to others as well, and before the flowers of May have faded he has succeeded in getting a mate. But the courtship of this gaudy fish has been no easy matter. Hundreds of his kind, as bright as he, have, like him, striven by the hour to clear the field of every rival; and the clear waters are often turbid with sand and grass torn from the bed of the stream, as the older males chase each other from point to point, endeavoring by a successful snap to mutilate each other's fins. No courtship battles among birds are more earnestly fought, and as the bird with bedraggled feathers is wise enough to withdraw from the contest and quietly seek a mate when his soiled plumage is in part restored, so the sunfish with torn fins retires from the contested nesting-ground. But not a sound has been made by these excited fishes except that of the rippling water when cut by their spiny fins as they chanced to reach above the surface.. Never, when for a moment quiet, have I chanced to see the delicate chain of silvery bubbles that escape from the mouth of the mud sunfish when, shall I say, calling to its mate. At night, I believe, the sunfish rests from his labors. I have not been able to detect any of his spring-time vivacity after sunset, and hence I am led to conclude that his sole dependence in securing a mate is in his brilliant coloring.

What a contrast is presented in the lazy, dull-colored cat-fish that slowly wanders over the muddy bed of the stream ; if perchance he is moving about at all during the day ! Not a motion can be detected that is not referable, without doubt, to so prosaic a matter as the search for food. If a dozen or more come together, it is but to hunt in concert, and nothing of the nature of a contest is to be seen. But after sunset every one of them becomes suddenly more animated, and there is a marked restlessness in every movement, as they congregate in large numbers in some limited area. At such a time, their presence is to be detected not only by the aid of submarine lanterns, and all the troublesome helps that one must employ to study fishes at night, but there is an opportunity given to use the ears as well as eyes, and by careful, patient watching and waiting we may hear, even from the deeper waters, a gentle humming sound which, if noticed at all, would by most people be referred to the insect-life teeming about them. If, knowing or suspecting the true origin of this gentle murmur, we can, without alarming the fish, float our boat directly above them, we will find that scores of chains of little air-bubbles are rising to the surface ; and as the sound increases or dies away, in proportion to the abundance or absence of the bubbles, it is safe to refer it to the fishes, which produce it by voluntarily expelling the air from their bodies.

I have not the space here to enumerate all the circumstances connected with these supposed voluntary emissions of sound by certain of our fishes, eight species of which I have particularly mentioned. Brief references to the others must here suffice. Concerning the first mentioned of our little list, the spineless perch or pirate, my knowledge has been largely derived from aquarial studies; and although the diminutive size of the largest specimens obtained renders it difficult to ascertain whether the sound accompanied the expulsion of air from their bodies, I have always felt quite sure that I detected it, and the actions of the fish, when the sexes were separated by fine sieving in the aquarium, were such as to make it highly probable that there was a sound made by the male fish which was heard by the females.

Of the percoid which I have called the "mud sunfish" there is no doubt. Not only in the muddy brooks where it is mostly found, but also when confined in an aquarium, this fish will utter at times a deep grunting sound that can not be mistaken. That it is voluntary, too, is evident from the quick, nervous movement of the whole body, and the wide distention of the gill-covers that accompanies the act. These sounds, and those made by the cat-fish, first called my attention to the subject of voluntary production of sound or "voice" in fishes. Like the spineless perch, this sunfish is, I think, strictly nocturnal in its habits, and, from aquarial observations, I am led to believe that it chooses a mate, and accompanies her to the nest for ovipositing only at night.

Of that interesting fish, the landlocked gizzard-shad, my observations have led to the detection of a very audible whirring sound, not unlike the deeper notes of a coarse string of an æolian harp. Others of the herring tribe, and particularly our shad, have likewise the power of emitting sounds that are distinctly audible, and vary but little from that described as uttered by the gizzard-shad. Those who may have noticed the vibrating noise made by the wind passing by a number of telegraph wires, will have heard a sound nearly identical. I judge that both sexes utter this sound in concert; but it may be that during the early spring the sexes separate, to come together again some time later when spawning commences, and, in such a case, that only the males "sing." This, however, is scarcely probable in the case of a non-migratory, land-locked species.

The mullet or chub-sucker is another example of those dull-colored, nocturnal fishes that frequent streams with muddy beds thickly overgrown with water-plants, and which have the power of audibly forcing air from their bodies. In April, with a noticeable deepening of their coloration, there is increased activity in every movement, and, wholly unlike their actions by day, at night they swim quite near the surface, and utter a single prolonged note, accompanied by a discharge of air-bubbles. They appear to project their jaws just above the water, and force the air from beneath their gill-covers immediately below the surface, as there are two parallel streams of bubbles. When seen in the moonlight, these bubbles appear like minute silver beads. Swimming in this way, the mullet will often proceed a hundred yards, uttering their peculiar "call" four or five times while passing over that distance.

In the lamprey we have a semi-nocturnal species that I have had but few opportunities of observing closely, as it frequents rapidly-running water, and spends much the greater portion of its time under flat stones. On two occasions I have watched them, when mated, and thought that they uttered a peculiar sound, quite unlike any other "fish-note" I had heard; but it was unaccompanied, so far as I could determine, by a chain of air-bubbles rising to the surface, as is always seen to accompany the sound uttered by the chub-sucker or cat-fish. This same noise, or one very similar, was made by them when captured and taken from the water, and in both instances may have been involuntary. From their peculiar anatomy they are an exceedingly interesting species with reference to the subject of voice; and I regret that my experience when keeping them in an aquarium did not confirm my suspicions when studying them in their proper habitat. When my lampreys were in an aquarium, I occasionally heard a prolonged buzzing sound that had many characteristics of what I have considered voice in other species, but it was too monotonous and protracted to be considered a voluntarily produced sound or vocal effort. If the more voice-like sounds heard, as mentioned, are characteristic of their breeding season, then it probably is strictly a "love-call," and certainly, when mated, these fishes are very amorous.

In all the instances so far mentioned, of voluntarily expressed sounds or utterances of fishes, they have been referred to in connection with their ordinary breeding habits; not that they are never heard at other times, but because these "calls" or "songs," or whatever they should be considered, are a marked feature of that season. In our common eel we have an instance of a fish possessing unmistakable evidences of voice, yet which may be said to have no breeding season, at least when found far inland. Without inquiring into the particulars of the recently ascertained breeding habits of the eel, it is sufficient here to say that, in countless thousands, they pass from the sea up our rivers, through the most insignificant inland brooks and often into isolated ponds. From these ponds they seldom wander, although not necessarily prisoners, even if direct water connection is broken. In these ponds they grow to a large size and live to a great age; yet summer after summer passes without any indication of their breeding. No species of fresh-water fish is more strictly nocturnal in its habits, and none are so easily studied, inasmuch as at night they are not only very active, but keep continually near the surface. In the matter of voice, eels utter a more distinctly musical sound than any other of the fish I have mentioned. It is a single note, frequently repeated, and has a slight metallic resonance. I have heard this sound only at night, and never when they are taken from the water by day, as when captured by a hook, so that I presume it is not involuntary. When a large number of eels are congregated in a small space, as when feeding on some dead animal, I have heard this note very frequently repeated, and from the volume of sound I judge that large eels only utter a note that is distinctly audible. It is well known that this fish occasionally leaves the water voluntarily and wanders a considerable distance to other streams or ponds; and when through protracted droughts a pond becomes quite dry, while other fishes perish, the eels suffer little inconvenience, as, snake-like, they crawl at night over a considerable stretch of land, guided by some undetermined sense to the nearest water. At such times the eel will occasionally utter this same clear note, especially if surprised. From what I have been able to determine concerning these overland journeys, they are undertaken only when the grass is well moistened with dew, and a surface of any extent devoid of thick vegetation is an effectual barrier to their progress. I would add that I have noticed, when "bobbing" for eels, or catching them in a manner that inflicts no injury to their mouths, that when squirming about the bottom of the boat they not unfrequently utter this same sound, not inaptly compared, perhaps, to the faint squeak of a mouse.

I have given one instance, that of the common sunfish, of a fish that is strictly a diurnal species, of bright coloration, and that passes through the various phases of courtship and nidification without uttering a sound; and on the other hand, more or less in detail, referred to several other fishes that are all of dull coloration, are nocturnal in their habits, and, whether voluntarily or not, certainly at times do utter sounds. They can not be considered as simply making such a noise as would result from certain muscular movements. The action that produces the sound, on the contrary, I have been led to believe is intentionally performed in order that the sound may result, and the fish intends it as a call, which is responded to by those hearing it, and for whom it was intended.

When we carefully study the entire ichthyic fauna of a given locality, say of a given stream, as I have done in this case, there will undoubtedly be found some exceptions to this supposed rule of dissociation of coloration and voice; but these may be less in number than appear to us, when we consider how many species are found in every stream that are so diminutive that it can not be determined to which class they really belong. Thus, while many are dull-colored and doubtless possess voice, it is too faint for us to hear; but, from the fact that this peculiarity can be determined in some of the larger species, it is not improbable that in earlier geological eras fishes generally were of somber tints, and possessed more marked vocal powers than at present, and that, in the subsequent differentiation of genera and species, color was more and more evolved as a generic character, and voice became proportionately less a feature of our fishes, but was retained in some, and reappears in still stronger development in those connecting links between fishes and higher vertebrates, culminating in the batrachians, where it is perfected by the presence of a larynx.

Professor J. C. Galton has, in the "Popular Science Review" for October, 1874, most scientifically discussed this whole subject, and a brief quotation from his able paper is a fit ending to my scanty notes on this most interesting phase of animal life. He writes: "Not only is there every reason to believe that the majority of sounds produced by fishes are not casual utterances, but are truly voluntary, but there is among such as give vent to them a most remarkable development of the organs of hearing in all essential particulars, for example, in the semicircular canals, otoliths and nerves, correlative with the degree of perfection of the instrument. Further than this, as the sounds generally excel in frequency and intensity at the breeding season, it will not be unreasonable to regard them—granting, as we do, that the chirp of the cricket and the croak of the frog is each in its way an alluring serenade—as nuptial hymns, or, to use language ascribed to Plutarch, as 'deafening epithalamia.' More than this: seeing that the carp, and others of the same family, have given unmistakable proofs of their aptitude to receive some rudiments of education, and in particular to perceive certain sounds, it can yet be possible that the moral admonitions of a St. Anthony of Padua—by many still regarded as a work of supererogation—may, no less than the amorous twang of the vesical zither, after all not have fallen upon totally deaf ears."

APPENDIX.

LIST OF THE MAMMALS, BIRDS, REPTILES, BATRACHIANS, AND FISHES OF MERCER COUNTY, NEW JERSEY.

MAMMALS.

Wild-Cat. *Lynx rufus.*

Occasional. At the time of the settlement of this neighborhood by European colonists, wild-cats were very abundant, as the references thereto by early writers indicate. A century later they were not abundant except at long distances from the settlements. Kalm (1749) refers to them as common to the mountainous regions up the valley of the Delaware. Referring to the abundance of deer in that region, he remarks: "Among their enemies is the *Lynx* of this country (New Jersey). . . . They climb up the trees, and, when the stags pass by, they dart down upon him, get fast hold, bite, and suck the blood, and never give over till they have killed it." In what is now Sussex County, New Jersey, and Pike County, Pennsylvania, on the opposite side of the river, wild-cats are still to be found, but are by no means abundant.

The domestic cat returns to a feral state much more commonly than is supposed, and the offspring of such cats are noticeably larger, fiercer, and more active than any tame cats that I have ever seen. I am even strongly inclined to believe, but will not be positive, that the offspring in the third generation are always of a uniform blue-gray color.

These domestic cats "run wild," and their offspring are quite as arboreal as the true *Lynx rufus.*

Weasel. *Putorius vulgaris.*

Common. This species is also known as the "little weasel" by those who can distinguish it from the following.

Weasel. *Putorius ermineus.*

Common. I have recently learned of several instances where weasels have taken up their abodes in the cellars of houses situated on the outskirts of towns. While unable to climb as readily as can the rat, the weasel will, when once established where rats are abundant, either destroy them or frighten them away. The same is true of them in the country; and I doubt if the farmer is not profited more by the lessening of the numbers of rats and mice than he loses, on the other hand, by the destruction of a few chickens in the course of a year.

Mink. *Putorius vison.*

Skunk. *Mephitis mephitica.*

Otter. *Lutra Canadensis.*

In some localities, even though thickly settled, otters seem to be increasing in numbers. During the summer the dense vegetation affords them sufficient cover, and, being exceedingly cunning, they are able to baffle pursuers, whether men or dogs. In the winter, however, the odds appear to be against them, and quite a number are reported as trapped or shot during this time of year.

Raccoon. *Procyon lotor.*

This animal is still found in the more unsettled parts of the county, but can not be said to be anywhere abundant. It is nocturnal in habit, and cunning enough to keep away from dogs; and so often lives for months near a farm-house without its presence being suspected.

Little Brown Bat. *Vespertilio subulatus.*

Silvery Bat. *Vespertilio noctivagans.*

Carolina Bat. *Vespertilio fuscus.*

Little Red Bat. *Atalapha Novæboracensis.*

The last of this series of bats is by far the most abundant, and, unlike the others, is less sensitive to changes of weather. It is the latest to disappear on the approach of winter; often flies at noonday, in midwinter, if the day is warm and not too bright; and the earliest to appear in spring.

Mole. *Scalops aquaticus.*

My observations of this animal lead me to believe that the specific name of "aquaticus" is essentially inappropriate. With us, the animal is confined to the highest and driest of our upland fields, and appears to have a decided aversion even to damp soils.

Hairy-tailed Mole. *Scapanus Breweri.*

This species is far less common than the preceding, and of late years I have seen no specimens of it.

Star-nosed Mole. *Condylura cristata.*

This curious animal is essentially an aquatic species, as observed by me. It frequents only the low, wet meadows, in which it burrows as extensively as the scalops does in the upland. I have occasionally found openings to its burrows beneath the surface of the water, and know, from recent observation, that the animal is an excellent swimmer.

I am convinced that this species hibernates, and often the meadows in which its winter nests are situated are covered with water for from two to four days at a time. Such periods of submergence do not appear to affect the hibernating moles in any way; but a summer freshet of like duration invariably proves fatal to great numbers of them.

Shrew. *Blarina brevicauda.*

The statement made in the body of the book, that I have never found a shrew near home, no longer holds good; but I let it stand, for the fact that I have recently seen and captured a specimen is all that I can say. On the 10th of August, 1883, my son brought me a dead shrew which he had found, and on the 30th of September following, while listening to the rose-breasted grosbeaks that were singing in the woods near by, I saw a small mammal leap by me. Its movements were not like those of a mouse, and I gave chase. It endeavored to hide in the heaps of loose dead leaves, but was easily captured. It proved to be a short-tailed shrew, and is the only living specimen I have ever seen.

Flying Squirrel. *Sciuropterus volucella.*

I have recently had my attention called to the small size of the flying squirrels found here, as compared with the dimensions given by Audubon and Bachman, Godman, and others. It would certainly seem as if they had shrunken considerably during the past fifty years. Is this due to the fact that food is less abundant and the environment less favorable?

Gray Squirrel. *Sciurus Carolinensis.*

It is but very seldom that a black squirrel is now seen in this neighborhood, but formerly they were very common. Family papers in my possession, dating back a century and a half ago, refer to "damages to crops caused by troops of great black squirrels."

Red Squirrel. *Sciurus Hudsonius.*

The general destruction of heavy growths of timber has caused this destructive squirrel to become comparatively scarce. They are often more abundant, however, than we suppose. This fact was forcibly brought to my attention during the past summer, when a pair of them were found nesting in a hollow locust-tree within ten steps of my front door. These squirrels had evidently been several weeks in this tree, yet no one had seen them. Subsequent observations revealed the fact that this particular pair were essentially crepuscular in their habits, and even in the gloaming, when they chanced to go abroad, their movements were exceedingly stealthy until they felt that they were well out of sight and hearing. Did not these squirrels realize the danger of living so near an occupied house, and act with unusual caution in consequence of such fear? I think so.

Chipmunk. *Tamias striatus.*

This common mammal appears to be increasing in numbers.

Woodchuck. *Arctomys monax.*

Although so common in most localities, few are found in Mercer County.

Jumping Mouse. *Zapus Hudsonius.*

While probably the fact that this species is strictly nocturnal makes it appear less abundant than it really is, still it is certainly nowhere to be found in great numbers. I think no one will be likely to find more than one or two pairs during a summer, although Dr. Godman remarks that "it breeds very fast, and may occasionally become injurious to the farmer."

White-footed Mouse. *Hesperomys leucopus.*

Albinism is quite common with this species, both partial and complete.

Meadow Mouse. *Arvicola riparius.*

That there are two or three species of so-called mice, other than the above, found in this neighborhood, is highly probable; but, as stated in the body of the work, I have not been able to identify them.

Muskrat. *Fiber zibethicus.*

Kalm mentions the well-known habit of the muskrat, of eating the ordinary river mussels (*unios*), and intimates their depending largely upon them for food. Godman does not refer to this, but states that their food is wholly vegetable matter; adding, "It has been imagined that this animal feeds also upon fish . . . an opinion which the structure of the teeth, stomach, and intestines sufficiently contradict." De Kay, on the other hand, says, "It is also extremely fond of the fresh-water mussel (*unio*), heaps of which, in a gnawed and comminuted state, may be found near their retreats. As a matter of fact, the muskrat not only consumes quantities of mussels, but other animal matter whenever it can be obtained. I have knowledge of their seizing ducklings and dragging them to their burrows, and have seen them in a mill-pond quarreling over the remains of a dog that had been drowned."

Rabbit. *Lepus sylvaticus.*

Of the few mammals of considerable size still to be found in long-settled neighborhoods, the rabbits seem best to have withstood the encroachments of man upon their haunts and the persecution of a host of enemies. They are probably as abundant as a century ago, benefiting more by the destruction of their natural enemies, than suffering from the persecution of man and dogs.

Opossum. *Didelphis Virginiana.*

During the past three or four years these animals have increased quite rapidly in numbers, and become less wary, or at least frequent localities that are less well adapted to shield them by day than are their usual woodland haunts. As an article of food they are highly prized by many; but their merits as such seem to me largely overstated. While not disposed to regularly hibernate, they can sleep for weeks without food.

BIRDS.

Dr. William P. Turnbull, in preparing his classical "Birds of East Pennsylvania and New Jersey," * remarks in his preface: "From the geographical position of the district it is particularly favorable for observation, being the resort, at some period of the year, of a large proportion of the birds of this continent; and, from the fact of its being the temporary resting-place of most of the migratory birds, there is probably no district of the same extent in this country that is frequented by such a number of species. A considerable number of our summer visitants from the Gulf States and Mexico appear to make it their northern limit, while other flocks remain only a short period in spring, and migrate still further north, penetrating as far as British America to breed; and these again arrive in autumn on their return journey to their winter retreats. It may likewise be noted that the district is the southern limit of many species which breed at Hudson's Bay and the fur countries, and pass the winter on the Delaware and Chesapeake, thus forming a line of separation, so to speak, for the migratory flights of many interesting birds coming from opposite directions.

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* "The Birds of East Pennsylvania and New Jersey." By William P. Turnbull, LL. D. Glasgow: Printed for private circulation. 1869, 4to.

"On consulting the list, however, it will be remarked that the proportion of what may be considered resident birds is small. This fact seems to have attracted observation as far back as the time of Dr. Benjamin S. Barton, who published a work, entitled 'Fragments of Natural History,' about seventy years ago, in which it is stated that, in the district now spoken of, very few species remain all the year, and that even of these there appeared to have been a partial migration in severe winters; such birds, especially, as lived on insects and small fruits being compelled to retire southward—a fact still noticeable at the present day—many species that usually migrate remaining in mild and open winters. Closer observation of late years, however, has enabled ornithologists to affirm with certainty that, of so-called migratory birds, a greater number pass the winter with us than has been hitherto supposed."

Elsewhere in his preface the author further remarks:

"The diffusion of well-authenticated information regarding the distribution of American birds is yet a matter for future observation. There have been, no doubt, many important contributions on this subject, of late years, yet the field is so extensive that many years must elapse before we can lay claim to a thorough knowledge of many important particulars, which patient research and well-timed energy alone can solve. The author of the present little work, while claiming for it the merit of careful observation, extending over a period of several years, at the same time believes the plan of the catalogue to be capable of attaining more useful results if enlarged in proportion to the nature of the districts investigated. It is, therefore, to be hoped that accurate observers may undertake similar records, by means of which the next great work on the ornithology of our country may contain a better collection of facts, representing the phenomena of the remoter districts, than has yet been obtained."

Believing that I can best serve the purposes of working ornithologists by closely following the list given by Mr. Turnbull in his work, from which I have already so extensively quoted, I have in the following pages practically reproduced that list, with annotations based upon the observations of the sixteen years which have elapsed since Dr. Turnbull wrote his work. My list of birds, that may be said to constitute the ornithic fauna of Mercer County, numbers two hundred and twenty-one species; that given by Dr. Turnbull numbers three hundred and forty-two species, and is given as the complete enumeration of the birds of an area many hundred times as large as that referred to as the field of my own observations. Of the three hundred and forty-two species given by Dr. Turnbull, fifty-nine are under the heading of "Stragglers or Irregular Visitants"; which leaves us but two hundred and eighty-three species as characteristic of the fauna, or properly belonging to it. Deducting eleven species from my list of the birds of Mercer County, New Jersey, there remains a difference only of seventy-seven species between those observed by Dr. Turnbull in "that part of Pennsylvania eastward of the Alleghany Mountains, and of New Jersey, including the coast-line, which extends from Sandy Hook to Cape May," and those that I have seen in a very limited portion of the valley of the Delaware.

Wood-Thrush. *Turdus mustelinus.*

Strictly migratory, and sensitive to frost. Arrives early in April, if the weather is warm, and remains until November. It is more irregular than any other of our thrushes.

Hermit-Thrush. *Turdus pallasii.*

"Not uncommon. It arrives in April, and again late in October on its way south, when it is more abundant along the sea-coast. . . . A few have been observed during winter when that season has been open and mild" (Turnbull). They also remain, in scanty numbers, during summer, and breed. Wissahickon Creek, June, 1883.

Olive-backed Thrush. *Turdus Swainsonii.*

"Rare. It arrives in the end of April. A few also of this species have been seen in winter" (Turnbull). I have not found this thrush to be at all "rare," but very irregular in its appearance.

Wilson's Thrush. *Turdus fuscescens.*

Resident, or but partly migratory. It is not unusual to see them during the winter, if the weather is mild. At such times they seek shelter from the wind, and congregate largely on wooded slopes having a southern exposure.

Robin. *Turdus migratorius.*

This familiar species is wandering, rather than migratory. They are as abundant in January as in June; indeed, often much more so.

Brown Thrush. *Harporhynchus rufus.*

Migratory. Often appears as early as April 1st. "A few remain during mild winters" (Turnbull).

Mocking-Bird. *Mimus polyglottus.*

Rare. A pair of these birds have for two years past nested in the yard of a neighbor. "It appears to have been plentiful in former years, and, according to Bartram and Dr. Barton, even remained all the winter near Philadelphia" (Turnbull).

Catbird. *Galeoscoptes Carolinensis.*

Abundant everywhere. I think it is evident that a change is slowly coming over their migratory habits. They certainly arrive earlier and stay later than the dates mentioned by Wilson, Audubon, or Nuttall. Single birds have been seen during the winter.

Bluebird. *Sialia sialis.*

Whatever may have been the habit of this species, it is now, in no sense, migratory.

Golden-crowned Knight. *Regulus satrapa.*

Not uncommon. Seen both in spring and autumn usually; but also in winter, though less frequently. That they breed in Northern New Jersey is unquestionable.

Ruby-crowned Wren. *Regulus calendula.*

More abundant than the preceding, and is identical in all its habits. The two are frequently associated, especially in mid-winter, when a flock of a dozen or twenty is occasionally met with.

Blue-gray Gnat-catcher. *Polioptila cærulea.*

I have seldom met with this species, which can scarcely be recognized by a description of its voice, quoted by Jordan as "like a mouse with the toothache." It is said, on the contrary, to be really a fine singer. Dr. Turnbull does not give this species in his list.

Tufted Tit. *Lophophanes bicolor.*

Abundant. "Especially abundant in summer" (Turnbull). My observations have led me to conclude it was more common in autumn and winter than in summer.

Black-capped Tit. *Parus atricapillus.*

Very abundant. During the summer they are more retiring in their habits and stay more closely in heavily-timbered areas. In winter they at times almost outnumber the snow-birds.

White-bellied Nut-Hatch. *Sitta Carolinensis.*

Common. While to be found, on careful search, at any time of the year, they are certainly more abundant during the winter.

Red-bellied Nut-Hatch. *Sitta Canadensis.*

"Rather rare from October to April" (Turnbull). I have found it as late as June, and believe the species to be resident to a limited extent.

Tree-Creeper. *Certhia familiaris.*

"Abundant, but more so in winter than at other times of the year. I can detect no difference between it and that of Europe; it has the same shrill but feeble note, and its habits are identical" (Turnbull).

Carolina Wren. *Thryothorus Ludovicianus.*

Within the past few years this magnificent songster has become quite abundant, and is strictly resident. According to Dr. Turnbull, at the time he wrote it was "rather rare. It appears early in May on the borders of the Delaware. Mr. John Cassin informed me that he had occasionally seen this bird on the Wissahickon in winter."

Bewick's Wren. *Thryothorus Bewickii.*

Some years ago a few pairs of these birds were seen in my neighborhood; but they have been replaced by the Carolina wrens, that appear to have driven the others away.

House-Wren. *Troglodytes œdon.*

Abundant. Less sensitive to cold than formerly—say, fifty years ago. They arrive earlier and depart later than in the time of Audubon and Wilson. I have seen them as early as April 5th.

Winter-Wren. *Troglodytes hyemalis.*

Common, but not resident. The great similarity in appearance to the preceding, and coming from the north at about the time the house-wrens pass southward, has given the impression to many that the latter are not migratory.

Short-billed Marsh-Wren. *Cistothorus stellaris.*

"Rather rare from April to September" (Turnbull). I believe that more of these birds are to be found than is commonly supposed. I have found colonies of them in certain limited tracts of reedy meadows.

Long-billed Marsh-Wren. *Cistothorus palustris.*

Abundant in all marshy or tide-water meadows.

Horned Lark. *Eremophila cornuta.*

"Plentiful; appearing late in October and generally leaving in March, but some seasons it remains until April" (Turnbull.) If a cold northeaster occurs in September it often brings these birds, which, again, have been seen as late as May 10th.

Titlark. *Anthus Ludovicianus.*

"Common. It arrives from the north in October, and departs in April, but is more frequent in the autumn and spring migrations" (Turnbull). Scarcely common.

Creeping Warbler. *Mniotilta varia.*

Abundant from April to October. Seen often in winter.

Blue Yellow-backed Warbler. *Parula Americana.*

Common from April to October.

Worm-eating Warbler. *Helmintherus vermivorus.*

"Rather rare; arriving in the middle of May" (Turnbull). During the past ten years this has been one of our most abundant species, and one that reaches us as early as the middle of April.

Blue-winged Yellow Warbler. *Helminthophaga pinus.*

Somewhat rare, but variable in this respect.

Nashville Warbler. *Helminthophaga ruficapilla.*

Common. Often very abundant during the autumnal migration of the warblers generally.

Tennessee Warbler. *Helminthophaga peregrina.*

Not uncommon. Dr. Turnbull speaks of it as more common in autumn than in spring.

Golden-winged Warbler. *Helminthophaga chrysoptera.*

Quite rare, except in certain summers when warblers of every species are unusually abundant.

Cape May Warbler. *Perissoglossa tigrina.*

"Very rare; it arrives early in May, and again it visits us on its way south about the 10th of October" (Turnbull).

Summer Warbler. *Dendrœca æstiva.*

Abundant.

Black-throated Blue Warbler. *Dendrœca cœrulescens.*

Abundant. "A few remain to breed" (Turnbull).

Myrtle-Bird. *Dendrœca coronata.*

Abundant. Yearly becoming more abundant during the winter. Even the severe January of 1884 did not drive them away. Several specimens were seen that month.

Black and Yellow Warbler. *Dendrœca maculosa.*

"One of our most beautiful warblers, and rather frequent; coming early in May, and again in September" (Turnbull).

Blue Warbler. *Dendrœca cœrulea.*

"Rare. From May to end of August. The Blue Mountain warbler of Wilson is the young of this species" (Turnbull).

Chestnut-sided Warbler. *Dendrœca Pennsylvanica.*

"Not uncommon. Arriving early in May. A few remain to breed" (Turnbull).

Black-poll Warbler. *Dendrœca striata.*

Common in spring and autumn.

Blackburnian Warbler. *Dendrœca Blackburnia.*

Not common, but tarries to breed.

Bay-breasted Warbler. *Dendrœca castanea.*

"Rather rare, appearing late in April, and again in October. The young bird of this species is the autumnal warbler of Wilson" (Turnbull).

Yellow-throated Warbler. *Dendrœca dominica.*

Rare. I have seen but few specimens. This species is not in Dr. Turnbull's list.

Prairie Warbler. *Dendrœca discolor.*

Not uncommon. Upland fields, overgrown with rag-weed, are favorite localities.

Black-throated Green Warbler. *Dendrœca virens.*

"Rather frequent, arriving early in May and departing in October. It is more plentiful in the spring and autumn migrations" (Turnbull).

Pine-creeping Warbler. *Dendrœca pinus.*

"This species is rather rare in spring, but plentiful in autumn. Arriving early in April, and again in October. Many remain during summer" (Turnbull).

This is one of the few species of warblers that lingers in Central New Jersey long after the severe frosts have set in. I have seen them as late as December 3d.

Yellow Red-poll Warbler. *Dendrœca palmarum.*

Arrive in May and again in October.

Golden-crowned Thrush. *Siurus auricapillus.*

Very common in moist ground thick with underbrush.

Water-Wagtail. *Siurus nævius.*

Not as common as the preceding, but during no summer have I found it rare.

Water-Thrush. *Siurus motacilla.*

Not uncommon, but probably the least abundant of the three species of this genus.

Connecticut Warbler. *Oporornis agilis.*

"Rather rare. This species is very seldom met with in spring, but is, however, more frequent in autumn, appearing late in August" (Turnbull).

During the spring of 1882 and of 1883, I saw many specimens of these birds during the month of May.

Kentucky Warbler. *Oporornis formosus.*

"A southern species, and rather scarce. It arrives late in April" (Turnbull).

As has frequently happened during the past decade, during certain summers, warblers of all kinds would be phenomenally abundant. During such I have seen many of this species.

Maryland Yellow-Throat. *Geothlypis trichas.*

A specimen of this common warbler was seen on the 18th of March, 1883. This is unusually early for this species, which, however, usually anticipates the arrival, in spring, of the warblers generally, by two or three weeks. The specimen here mentioned was very active, kept much to the tops of the taller trees, and sang incessantly.

Mourning Warbler. *Geothlypis Philadelphia.*

I have seen but the one specimen of this warbler, to recognize it. A friend, who has carefully studied our warblers, reports it as "not uncommon in April and May."

Yellow-breasted Chat. *Icteria virens.*

Very abundant as a summer resident.

Hooded Warbler. *Myiodioctes mitratus.*

Very variable as to numbers. Dr. Turnbull speaks of it as "rather rare."

Green Fly-catcher. *Myiodioctes pusillus.*

"This bird appears early in May, and again in October, and is rather abundant" (Turnbull).

My impression is that they are also, to a certain extent, summer residents, and presumably breed here.

Canada Fly-catcher. *Myiodioctes Canadensis.*

"Frequent from the end of April to October" (Turnbull).

Redstart. *Setophaga ruticilla.*

Abundant. A summer resident.

Scarlet Tanager. *Pyranga rubra.*

Abundant. A summer resident.

Summer Redbird. *Pyranga œstiva.*

Rare. Formerly more abundant than the preceding.

Barn-Swallow. *Hirundo horreorum.*

Common. March to September 30th.

White-bellied Swallow. *Tachycineta bicolor.*

Common. Late in March to September 15th.

Cliff-Swallow. *Petrochelidon lunifrons.*

Common in colonies, which return year after year to the same nesting-places. April to September, both inclusive.

Bank-Swallow. *Cotyle riparia.*

Common. Early spring until late in October.

Rough-winged Swallow. *Stelgidopteryx serripennis.*

This is the least abundant of our swallows, but is never wanting altogether, I believe.

Purple Martin. *Progne subis.*

Common, where boxes for their accommodation are provided.

Cedar-Bird. *Ampelis cedrorum.*

"Abundant, but less frequent in winter than at other seasons" (Turnbull). My observations are the reverse. I certainly have seen much larger flocks and more of them in winter. During the severe January of 1884 they were exceedingly abundant.

Wax-Wing. *Ampelis garrulus.*

"Has been occasionally shot near Philadelphia" (Turnbull). I have seen two specimens of this northern species, both of which were killed near Trenton, New Jersey.

Red-eyed Fly-catcher. *Vireosylvia olivacea.*

Common from May until end of October.

Philadelphia Greenlet. *Vireosylvia Philadelphica.*

"Very rare" (Turnbull). I have met with but two specimens, and these were collected twenty years ago; but as these birds might readily be confounded with other greenlets, when simply seen "on the wing," it is probable that they are not so excessively rare as is generally supposed.

Warbling Greenlet. *Vireosylvia gilva.*

Common from May to October, both inclusive.

Blue-headed Fly-catcher. *Vireosylvia solitaria.*

"Rather rare, arriving in April and departing in October" (Turnbull).

Yellow-throated Fly-catcher. *Vireosylvia flavifrons.*

"Not uncommon from the end of April to September" (Turnbull). I have found the nests of this species in elm and maple trees; usually at a considerable elevation; above rather than below the so-called "nest-line."

White-eyed Vireo. *Vireo Novæboracensis.*

Common from March to October, both inclusive. Stragglers are occasionally met with in midwinter.

Butcher-Bird. *Collurio borealis.*

"Not uncommon, especially in winter. In March it migrates to the north, but many nestle on the mountain-ridges of the Alleghanies" (Turnbull).

Loggerhead Shrike. *Collurio Ludovicianus.*

This southern species is now found every summer in this neighborhood. I have seen half a dozen specimens within a year, and know of others collected within the past four or five years. This species appears to have become comparatively common since the great increase in the number of English sparrows, now so melancholy a feature of our ornithology; and the spread in the range of this and the preceding species of shrike is attributed to the unfortunate abundance of the perfidious foreign sparrow.

Pine Grosbeak. *Pinicola enucleator.*

Varies greatly in accordance with the character of the winter. Dr. Turnbull speaks of it as "rather rare."

Purple Finch. *Carpodacus purpureus.*

"Not uncommon from September to April, a few remaining during summer" (Turnbull).

Red Crossbill. *Loxia curvirostra.*

A winter visitant; at times quite abundant.

White-winged Crossbill. *Loxia leucoptera.*

"Rare, but in some winters more plentiful" (Turnbull). I saw them, in the summer of 1867, near the Delaware Water-Gap.

Linnet. *Ægiothus linaria.*

"Not uncommon in severe winters, coming early in November, and remaining until April" (Turnbull). I have not found the character of the winter to determine the question of their presence or absence. I have never known a winter when linnets were not seen.

Thistle-Bird. *Chrysomitris tristis.*

Common. Resident.

Pine Finch. *Chrysomitris pinus.*

Common in winter.

Snow-Bunting. *Plectrophanes nivalis.*

In winter.

Lapland Long-Spur. *Plectrophanes Lapponicus.*

"Very rare, and found only in severe winters" (Turnbull). My observations have determined that single specimens of this bird are not unusually found in the flocks of the preceding species.

Savannah Sparrow. *Passerculus Savanna.*

Transitory. Abundant only in spring and autumn.

Grass-Finch. *Poœcetes gramineus.*

Abundant, resident, and the most "domestic" of our birds. In the fields in which these birds are hatched they appear to remain throughout their lives. They are as abundant in January as in June. Dr. Turnbull considered them migratory, and speaks of their numbers as "being augmented in summer by flocks arriving early in April."

Yellow-winged Sparrow. *Ammodromus passerinus.*

"Common, arriving late in April, and departing in October" (Turnbull).

Henslow's Bunting. *Ammodromus Henslowi.*

Never common. Varies greatly in numbers from year to year.

Sharp-tailed Finch. *Ammodromus caudacutus.*

"Frequent on the salt marshes along the coast" (Turnbull). Not uncommon on the inland tide-water meadows of the Delaware River.

White-crowned Sparrow. *Zonotrichia leucophrys.*

Never abundant, but still not rare. They appear often as early as September, and remain until the spring following is well advanced.

White-throated Sparrow. *Zonotrichia albicollis.*

Common from September to May, often inclusive of the latter month.

Tree-Sparrow. *Spizella monticola.*

Abundant from October to April, both inclusive. A statement made by the writer in 1868 ("Geology of New Jersey"), that this species was "resident," was a careless blunder.

Field-Sparrow. *Spizella pusilla.*

"Common. Comes early in April and leaves in October" (Turnbull). If the weather is pleasant, they remain until December.

Chippy. *Spizella socialis.*

Resident, and also migratory, as stated by Dr. Turnbull.

Swamp-Sparrow. *Melospiza palustris.*

Abundant in all our reedy meadows. A sweet songster, with notes that are as liquid as the babbling of a brook.

Song-Sparrow. *Melospiza melodia.*

Resident, but to some extent may also be migratory. I can not perceive, however, that they are more abundant in summer than in winter.

Lincoln's Finch. *Melospiza Lincolni.*

Not abundant. Migratory.

Snow-Bird. *Junco hyemalis.*

Abundant from October to April, both inclusive.

Foxie Sparrow. *Passerella iliaca.*

Arrive in October usually, and remain until April 1st. They appear to be most abundant at the end of winter, when often quite large, loose flocks are seen associated with numbers of white-throats.

Black-throated Bunting. *Euspiza Americana.*

"Plentiful. Appearing early in May, and leaving in September" (Turnbull).

Rose-breasted Grosbeak. *Goniaphea Ludoviciana.*

Since 1880 this species has been increasing in numbers steadily. They come late in April, and remain until September 30th. The finest song-bird of North America.

Indigo-Bird. *Cyanospiza cyanea.*

Common from May to September, both inclusive; but so sensitive to cold storms that a cool August drives them southward.

Cardinal-Grosbeak. *Cardinalis Virginianus.*

Resident, and more lively and full of song at Christmas than in midsummer. Dr. Turnbull intimates that they are partly migratory; but I am inclined to believe this an error. There is, at least, no evidence of this in Mercer County.

Chewink. *Pipilo erythrophthalmus.*

Common from early spring until the leaves have fallen. According to Dr. Turnbull, "a few remain during winter, and may be found in well-sheltered localities."

Bobolink. *Dolichonyx oryzivorus.*

Appear early in May or April, if the weather is mild, and spread over the country as "bobolinks." In August they gather into large flocks, and follow the river valleys southward as "reed-birds" on the Delaware, and "rice-birds" in the Southern States.

Cow-Bird. *Molothrus pecoris.*

Common from March 15th to November 1st, and sometimes seen later in the year.

Red-winged Blackbird. *Agelaius phœniceus.*

Most abundant from February until November, but to be found even during midwinter.

Meadow-Lark. *Sturnella magna.*

Resident. Abundant.

Baltimore Oriole. *Icterus Baltimore.*

Very abundant. April 15th to October 1st are the dates of the arrival and disappearance of most of them; but a few stragglers are seen every year, both earlier and later than the dates given.

Orchard Oriole. *Icterus spurius.*

Equally common with the above. Arrives and departs at about the same time of year.

Rusty Grackle. *Scolecophegus ferrugineus.*

More abundant during some years than others, but at no time as common as the following.

Crow Blackbird. *Quiscalus purpureus.*

Common. Both resident and migratory.

Raven. *Corvus corax.*

Only occasionally seen "flying over."

Crow. *Corvus Americanus.*

Common. Resident.

Fish-Crow. *Corvus ossifragus.*

Rare. Dr. Turnbull speaks of it as migratory, stating that "it arrives early in April."

Blue Jay. *Cyanurus cristatus.*

Common. Dr. Turnbull speaks of it as "less numerous in winter than at other seasons." I have not found this, but the contrary to be true.

Forked-tailed Fly-catcher. *Milvulus forficatus.*

"Bonaparte procured a specimen of this bird near Bridgeton, New Jersey; another was shot by Audubon at Camden, near Philadelphia, in June, 1832" (Turnbull).

A specimen was collected in April, 1872, near Trenton, New Jersey, and presented by the writer to the Academy of Science, at Salem, Massachusetts.

King-Bird. *Tyrannus Carolinensis.*

Common. May to September, both inclusive.

Great-crested Fly-catcher. *Myiarchus crinitus.*

Common. May to September, both inclusive.

Peewee. *Sayornis fuscus.*

Common. March to October, both inclusive.

Wood Peewee. *Contopus virens.*

Abundant. April to October, both inclusive.

Olive-sided Fly-catcher. *Contopus borealis.*

"Very rare. It is generally seen early in May on its way north, and returns in September" (Turnbull).

Traill's Fly-catcher. *Empidonax Traillii.*

"Rare, but some seasons it is not uncommon in the spring, arriving about the middle of May" (Turnbull).

I am positive that it occasionally remains during the summer and breeds.

Green-crested Fly-catcher. *Empidonax Acadicus.*

"Frequent from the beginning of May to the middle of September. It is generally found in the most secluded parts of woods" (Turnbull).

Least Fly-catcher. *Empidonax minimus.*

"Rather rare, arriving in April on its northern migration, and returning early in September. A few remain to breed" (Turnbull).

Yellow-bellied Fly-catcher. *Empidonax flaviventris.*

"Rare. It arrives in the middle of April, on its way north. Dr. Slack found it breeding near Trenton" (Turnbull).

Whip-poor-will. *Antrostomus vociferus.*

Common. May to August, both inclusive.

Night-Hawk. *Chordeiles Virginianus.*

Common. April to September, both inclusive.

Chimney-Swallow. *Chætura pelagica.*

Common. April to October, both inclusive.

Humming-Bird. *Trochilus colubris.*

Common. Arrives as soon as the weather has become settled and fairly warm, and remains until frost, or until about the middle of October.

Kingfisher. *Ceryle alcyon.*

Both resident and migratory. Abundant.

Yellow-billed Cuckoo. *Coccygus Americanus.*

Common. Arrives early in spring and remains until October 1st.

Black-billed Cuckoo. *Coccygus erythrophthalmus.*

Not as common as the preceding. "It frequents the borders of small streams" (Turnbull).

Hairy Woodpecker. *Picus villosus.*

Common. Resident.

Downy Woodpecker. *Picus pubescens.*

Common. Resident.

Yellow-bellied Woodpecker. *Sphyrapicus varius.*

Common. Resident and partly migratory.

Red-bellied Woodpecker. *Centurus Carolinus.*

Not common. Migratory.

Red-headed Woodpecker. *Melanerpes erythrocephalus.*

Common. Apparently migratory.

Flicker. *Colaptes auratus.*

Common. Irregularly migratory.

Barn-Owl. *Strix pratincola.*

"Not rare, and more frequent in spring and autumn" (Turnbull).

Cat-Owl. *Otus Wilsonianus.*

Not abundant of late; but twenty or more years ago were common in the swampy woodlands.

Marsh-Owl. *Otus brachyotus.*

Common. Dr. Turnbull refers to it as migratory, "arriving in November, and departing in April." This is partly an error. I have occasionally found it breeding in hollow trees, near Trenton, New Jersey.

Barred Owl. *Syrnium nebulosum.*

Rare. Usually seen in autumn and winter.

Saw-whet Owl. *Nyctale Acadica.*

Comparatively abundant since 1877. Resident, and breeds annually in swampy lands near Trenton, New Jersey.

Screech-Owl. *Scops asio.*

Common. Resident.

Great Horned Owl. *Bubo Virginianus.*

Rare. Occasionally a "family" of them are met with in winter.

Snowy Owl. *Nyctea scandiaca.*

Rare. A winter visitant. More common during some winters than others.

Hawk-Owl. *Surnia ulula.*

Rare. Probably our rarest winter visitant. "Is occasionally found in severe winters. One was shot at Haddington, near Philadelphia, in 1866" (Turnbull).

Duck-Hawk. *Falco communis.*

Very rare. "During autumn and winter it frequents the marshes along the sea-coast and the courses of rivers, preying upon wild-fowl" (Turnbull).

Pigeon-Hawk. *Falco columbarius.*

Not common. Migratory; but occasionally breeds in New Jersey.

Sparrow-Hawk. *Falco sparverius.*

Abundant. Resident.

Fish-Hawk. *Pandion haliætus.*

Abundant. Migratory.

Swallow-tailed Hawk. *Nauclerus furcatus.*

I saw a specimen of this hawk in November, 1883. "Has been seen once or twice in Pennsylvania. Mr. John Krider shot one near Philadelphia in 1857" (Turnbull).

Mississippi Kite. *Ictinia subcœrulea.*

Specimens of this hawk have been killed in Mercer County during the past ten years. It is, however, exceedingly rare.

Marsh-Hawk. *Circus Hudsonius.*

Common during the winter, but less so during the rest of the year.

Goshawk. *Astur atricapillus.*

Rare, and seen during the winter only.

Sharp-shinned Hawk. *Accipiter fuscus.*

Abundant. Resident.

Cooper's Hawk. *Accipiter Cooperi.*

Abundant. Resident.

Hen-Hawk. *Buteo borealis.*

Common. "Much more frequent in autumn and winter; haunting meadows and cultivated districts" (Turnbull).

Winter-Falcon. *Buteo lineatus.*

Not as abundant as the preceding.

Broad-winged Hawk. *Buteo Pennsylvanicus.*

"Rare. This hawk is also more frequently seen in winter."

Rough-legged Buzzard. *Archibuteo lagopus.*

Common; particularly during the winter. Dr. Turnbull refers to this bird, when it has acquired the melanistic plumage, as a distinct species—*Archibuteo Sancti Johannis.* The plumage varies from dirty white to black.

Ring-tailed Eagle. *Aquila chrysætus.*

Rare. A single specimen was seen by the writer several times during the winter of 1883–'84.

Bald Eagle. *Halietus leucocephalus.*

Occasionally specimens are seen, particularly during the autumn and winter; but these birds are yearly becoming more scarce.

Turkey-Buzzard. *Cathartes aura.*

Common. Irregularly migratory.

Wild Pigeon. *Ectopistes migratoria.*

No longer abundant in this neighborhood.

Turtle-Dove. *Zenædura Carolinensis.*

Common. Migratory. Dr. Turnbull states that "many remain during the winter."

Quail. *Ortyx Virginianus.*

Common. Resident.

Ruffed Grouse. *Bouasa umbellus.*

Formerly abundant, but now quite rare.

Black-bellied Plover. *Squatarola Helvetica.*

"It appears late in April, and again in September, a few remaining on the uplands to breed" (Turnbull).

This species, associated with golden plovers, are most frequently seen in August and September, in Mercer County; sometimes flocks of several hundred being found. They never tarry long, but seem to be migrating.

Golden Plover. *Charadrius fulvus.*

"Common, appearing in the end of April, and again early in September" (Turnbull).

Killdeer Plover. *Ægialitis vociferus.*

Common as a visitor, but few now remain to breed. Less than half a century ago they were a familiar bird in our upland fields, and bred in newly plowed fields. Now they are found only in spring and autumn, along our larger creeks and the river-shore. "Especially abundant along the sea-shore in winter" (Turnbull).

Wilson's Plover. *Ægialitis Wilsonius.*

"Rather rare. Arrives early in May" (Turnbull). Associated with other small "beach birds," this plover is occasionally found in considerable numbers along the shores of the Delaware River, above the reach of tide-water.

Ring-necked Plover. *Ægialitis semipalmatus.*

Properly a "shore bird," but, like the preceding, is found along the mud-flats of the Delaware River, particularly in August.

Piping Plover. *Ægialitis melodus.*

Like the above, this is properly a bird of the sea-coast, that frequently wanders up our river-valleys far beyond the limits of salt water. They are often exceedingly abundant after storms, especially when an easterly wind has prevailed.

Red Phalarope. *Phalaropus fulicarius.*

"A few examples of this species are obtained every season" (Turnbull). I have seen a specimen, in the flesh, killed on the river at Trenton.

Woodcock. *Philohela minor.*

Common. Resident to a limited extent. Usually migrate, appearing about March 1st.

Snipe. *Gallinago Wilsonii.*

Common. Migratory. A few remain, however, during the winter. Have been known to breed in Mercer County, New Jersey.

Peep. *Ereunetes pusillus.*

Irregularly abundant, in spring and autumn, along the river-shore.

Least Sandpiper. *Tringa minutilla.*

Irregularly abundant, in spring and autumn, along the river-shore.

Sanderling. *Calidris arenaria.*

Single specimens of this coast species are so freqnently found associated with other "sand-snipe," that it may properly be considered as a spring and autumn visitant. Indeed, it is doubtful if not all of the marine waders do not occasionally come so far inland.

Telltale. *Totanus melanoleucus.*

Common during the spring, summer, and early part of autumn.

Yellow Shanks. *Totanus flavipes.*

Even more abundant than the preceding, with which they are usually associated.

Solitary. *Totanus solitarius.*

Common. Migratory. Frequents upland localities.

Teeter. *Tringoides macularius.*

Abundant everywhere from May to October, both inclusive.

Field-Plover. *Actiturus Bartramius.*

"Plentiful from the middle of April till late in September" (Turnbull).

Great Blue Heron. *Ardea Herodias.*

"Common, arriving in April. A few, however, remain during winter" (Turnbull).

This species is quite common near Bordentown, New Jersey, on the meadows.

Great White Heron. *Herodias egretta.*

"Rather rare, arriving about the middle of May" (Turnbull).

Snowy Egret. *Garzetta candidissima.*

A few are seen every summer, along the Delaware River, associated with herons of other species.

Blue Heron. *Florida cœrulea.*

"Rare" (Turnbull). I am surprised to find this species mentioned as rare in New Jersey. It is always abundant about the meadows and river-banks, from Trenton southward to the capes.

Green Heron. *Butorides virescens.*

Abundant. Migratory. April to October, both inclusive.

Night-Heron. *Nyctiardea grisea.*

Abundant. Migratory and resident to a limited extent.

Yellow-crowned Night-Heron. *Nyctherodius violaceus.*

"A rare straggler from the south" (Turnbull). I have found it frequently along the river, north of Trenton, New Jersey.

Bittern. *Botaurus lentiginosus.*

Common. It comes to us early in April and remains until the autumn is well spent.

Least Bittern. *Ardetta exilis.*

Frequent, but not as abundant as the preceding. Migratory.

Ibis. *Ibis falcinellus.*

"Last season (1866) Mr. John Krider shot a specimen just below Philadelphia. At long intervals it has been seen on the River Delaware, and also at Egg Harbor" (Turnbull). It has been found on Crosswicks Creek, Mercer County, New Jersey, on two occasions; both specimens being procured.

King-Rail. *Rallus elegans.*

King-Rails frequent the "mucky" meadows of my farm every year. In the summer of 1882 my son found the nest of this bird for the first time. It was formed of long, dead grass, with a base of small sticks, and was placed at the foot of a low bush. It contained eight eggs, similar in appearance to those of the common Clapper-Rail of our sea-coast.

Virginia Rail. *Rallus Virginianus.*

Very rare along the Delaware River, until the vicinity of salt water is reached, where, in the broader stretches of tide-meadows, it becomes more frequent.

Sora. *Porzana Carolina.*

"Abundant, arriving from the south early in May. About the beginning of August it returns from the north in great numbers, and finally leaves us in October. A few remain to breed during summer" (Turnbull).

Yellow Rail. *Porzana Novæboracensis.*

Quite rare. I have seldom seen more than one or two during the season.

Florida Gallinule. *Gallinula galeata.*

"A very rare summer visitant, from the middle of May to late in October, on the Delaware and Susquehanna" (Turnbull).

Purple Gallinule. *Gallinula martinica.*

Very rare.

Coot. *Fulica Americana.*

Common from early in April until late in autumn. Dr. Turnbull speaks of it as "rather rare."

Wild Goose. *Branta Canadensis.*

Common. Migratory.

Mallard. *Anas boschas.*

Common. Migratory.

Black Duck. *Anas obscura.*

Common. Migratory.

Sprig-Tail. *Dafila acuta.*

Common. Migratory.

Widgeon. *Mareca Americana.*

Common. Migratory.

Blue-winged Teal. *Querquedula discors.*

Common. Migratory.

Green-winged Teal. *Nettion Carolinensis.*

Common. Migratory.

Wood-Duck. *Aix sponsa.*

Common. Resident and migratory. They breed in hollow trees, in large numbers, and I have seen them as frequently during winter as in summer.

Buffle-headed Duck. *Bucephala albeola.*

Common. Migratory. During the freshets of winter and early spring almost all the marine species of ducks are found in greater or less numbers along the river. Geese, brant, and broad-bills, especially, are often killed; and numbers of canvas-backs and red-heads, also, but less frequently. The list given, excepting the goose, are those that are usually found when there is a "flight of wild fowl."

Gull. *Larus argentatus.*

Common, immediately after northeast storms.

Gull. *Larus Delawarensis.*

Common after storms. Abundant nearer Delaware Bay.

Occasionally, single gulls are seen inland, or flying over the river—not only those mentioned, but other species.

Tern. *Sterna hirundo.*

Occasionally, and particularly after severe easterly storms, terns are quite abundant about the river. They never remain, however, more than two or three days.

Loon. *Colymbus torquatus.*

Not uncommon during autumn and winter, and occasionally seen in summer.

Red-throated Diver. *Colymbus septentrionalis.*

I saw a specimen of this diver that was killed on the river in February, 1879. I carefully examined the specimen a few hours after it was shot.

Red-necked Grebe. *Colymbus holboellii.*

Eared Grebe. *Dytes auritus.*

Devil-Diver. *Podilymbus podiceps.*

Common. Migratory, but irregularly so.

REPTILES.

Land-Turtle, or Box-Tortoise. *Cistudo clausa.*

Muhlenberg's Turtle. *Chelopus Muhlenbergii.*

Rough-backed Turtle. *Chelopus insculptus.*

Speckled Turtle. *Nanemys guttatus.*

Blanding's Turtle. *Emys meleagris.*

The species that I take to be the above is exceedingly rare, and, if not the same, is a nondescript. It does not in every particular agree with the descriptions of the species as given by authors generally.

Painted Turtle. *Chrysemys picta.*

Red-bellied Turtle. *Pseudemys rugosa.*

Mud-Digger. *Cinosternum Pennsylvanicum.*

Stinking-Turtle. *Aromochelys odoratus.*

Snapper. *Chelydra serpentina.*

Fence-Lizard. *Sceloporus undulatus.*

These lizards are yearly becoming more scarce, as the areas of woodland are being "cut off."

Hog-nosed Snake. *Heterodon platyrhinus.*

Water-Snake. *Tropidonotus sipedon.*

Leather-Snake. *Tropidonotus leberis.*

Brown Snake. *Storeria De Kayi.*

Slender Garter-Snake. *Eutænia saurita.*

Garter-Snake. *Eutænia sirtalis.*

Black Snake. *Bascanion constrictor.*

Green Snake. *Cyclophis æstivus.*

Ring-necked Snake. *Diadophus punctatus.*

Chain-Snake. *Ophibolus doliatus.*

This snake is also known as "thunder and lightning" snake.

Blind-Worm. *Carphophiops amœna.*

BATRACHIANS.

Spring-Frog. *Rana halecina*

Pickerel-Frog. *Rana palustris.*

Green Frog. *Rana clamitans.*

Bull-Frog. *Rana Catesbiana.*

Wood-Frog. *Rana temporaria.*

Spade-Foot Toad. *Scaphiopus solitarius.*

Tree-Toad. *Hyla versicolor.*

Pickering's Tree-Toad. *Hyla Pickeringii.*

Peeper. *Acris crepitans.*

Toad. *Bufo lentiginosus.*

Spotted Triton. *Diemyctylus viridescens.*

Dusky Salamander. *Desmognathus fusca.*

Red-backed Salamander. *Plethodon erythronotus.*

Red Triton. *Spelerpes ruber.*

Purple Salamander. *Gyrinophilus porphyriticus.*

Tiger-Triton. *Amblystoma tigrinum.*

There are other salamanders found in Mercer County, I am confident, but only the above have I been able positively to identify. Of the latter species, I have seen but the one specimen.

Hellbender. *Menopoma Alleghaniense.*

Accidental. Believed to have escaped from a traveling "show."

FISHES.

Hog-Fish, Sand-Perch. *Percina caprodes.*

Darter. *Boleosoma Olmstedi.*

Crimson Darter. *Pœcilichthys erochrous.*

Darter. *Pœcilichthys fusiforme.*

Yellow Perch. *Perca flavescens.*

Rock-Fish. *Roccus lineatus.*

White Perch. *Roccus Americanus.*

Mud Sunfish. *Acantharcus pomotis.*

River Sunfish. *Lepomis auritus.*

Blue Sunfish. *Lepomis pallidus.*

Rare. Single specimens, now and then, have been found in the Delaware.

Sunny. *Lepomis gibbosus.*

Banded Sunfish. *Mesogonistius chætodon.*

Spotted Sunfish. *Enneacanthus simulans.*

Spotted Sunfish. *Enneacanthus obesus.*

The first mentioned of these "spotted" sunfish is extremely abundant, but the other is uncommon. Very probably they are not distinct.

Goggle-eyed Perch. *Pomoxys sparoides.*

Only occasional specimens met with in the river.

Pirate. *Aphododerus Sayanus.*

Mud-Blower, or Ling. *Lota maculosa.*

Discovered in the Delaware River in 1883.

Stickleback. *Apeltes quadracus.*

Rare in the inland streams.

River Minnow, Blunt Heads. *Fundulus diaphanus.*

Peacock Minnow. *Fundulus ornatus.*

River Minnow. *Fundulus nigrofasciatus.*

There are two other species, which, I believe, occasionally ascend the river as far as Mercer County. Those mentioned are exceedingly abundant, particularly the former.

Mud Minnow. *Umbra limi.*

Bill-Fish, Silvery Gar, "Snippick." *Belone acutirostris.*

Pike. *Esox reticulatus.*

Ditch-Pike. *Esox fasciatus.*

Smelt. *Osmerus mordax.*

Rare in the Delaware, but common in other rivers of the State.

Shad. *Alosa sapidissima.*

Alewife. *Pomolobus pseudoharengus.*

Gizzard Shad. *Dorysoma cepedianum.*

Blunt-nosed Minnow. *Hyborhynchus notatus.*

Silvery Minnow. *Hybognathus nuchalis.*

Spawn-Eater. *Cliola Hudsonia.*

Smelt-Shiner. *Cliola Storeriana.*

Minnie. *Cliola procne.*

Silver Fin. *Cliola analostana.*

Red Fin. *Minnilus cornutus.*

Minnie. *Minnilus chalybæus.*

Rosy Minnow. *Minnilus amœnus.*

This species was discovered and described by me in 1873. (See "American Naturalist," vol. viii, p. 334.)

Rosy Dace. *Squalius funduloides.*
Roach. *Notemigonus chrysoleucus.*
Minnie. *Hemitremia bifrenata.*
Chub. *Semotilus corporalis.*
Chub. *Semotilus bullaris.*
Long-nosed Dace. *Rhinichthys nasutus.*
Black-nosed Dace. *Rhinichthys atronasus.*

Sucker. *Myxostoma macrolepidota.*
Mullet. Chub-Sucker. *Erimyzon sucetta.*
Mud-Sucker. *Hypentelium nigricans.*
River-Sucker. *Catostomus communis.*
River-Sucker. *Carpiodes cyprinus.*

Catfish. *Ichthælurus punctatus.*
Catfish. *Amiurus catus.*
Stone-Cat. *Noturus gyrinus.*

Eel. *Anguilla rostrata.*
Gar. *Lepidosteus osseus.*
Sturgeon. *Acipenser sturio.*
Sturgeon. *Acipenser brevirostris.*
Lamprey. *Petromyzon marinus.*

There are other species of fresh-water fishes, than those enumerated, in the valley of the Delaware River; some of which are confined to the mountainous regions, north of the county boundaries; others do not wander so far inland from the sea-coast as Mercer County, except on rare occasions.

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